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COURSE of LECTURES

UPON THE
VISCERAL ANATOMY and VITAL
OECONOMY of HUMAN BODIES:

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THE SECOND EDITION.

IN TWO VOLUMES.

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THE SECOND EDITION

IN TWO VOLUMES

VOL. I

THE

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PHYSIOLOGIA;

O R, A

COURSE of LECTURES

ON THE

VISCERAL ANATOMY and LIVING
OECONOMY of the HUMAN BODY, &c.

LECTURE XIV.

Of the sense of touch and feeling.

§ 421. **T**HE other use and office of the brain and nerves (§401.) besides motion is to *perceive*; that is, to suffer a change from the actions or impressions of external bodies, and thereby excite other corresponding changes or representations in the mind. We shall, therefore, first lead our examination to each of the senses in particular, and then consider, what is common to all of them; with

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the changes which follow from thence in the common sensory and in the mind.

§ 422. The sense of touch is understood in a twofold manner; for, by this term, in general, we call all changes of the nerves, arising from heat, cold, roughness, smoothness, weight, moisture, dryness, or other affections of external bodies, in whatever part or organ they are applied, to cause a change. In this sense, the touch or feeling is ascribed to almost all parts of the human body, to some more, to others less; for thus even pain, pleasure, hunger, thirst, anguish, itching, and the other sensations belong to the sense of feeling.

§ 423. But, in a somewhat different and more proper acceptation, the sense of touch is said to be the change arising in the mind from external bodies, applied to the skin, more especially at the ends of the fingers. For, by the fingers, we more accurately distinguish the tangible qualities of things than by other parts of our body.

§ 424. Indeed, this sense does not easily distinguish any particles by the skin, which it does not touch; but since the touch is more peculiarly ascribed to the cutaneous papillæ, therefore the structure of the skin is to be first described. That part then, which is called the *true skin*, is composed of a thick cellular network, whose fibres and plates are closely compacted and interwove together in an intricate manner, which renders it porous, and capable of contracting or dilating. Within this substance run many small arteries, which
come

come from the subcutaneous ones, which, though neither large nor of a very great length, are yet numerous in some parts of the skin, which look red as in the cheeks; but in other parts of the skin, they are fewer in number. But the veins of this part arise in great numbers from the subcutaneous network, and the nerves likewise in the skin are very numerous, but they vanish or disappear so suddenly, that it is very difficult to trace the ultimate extremities of them. Betwixt the skin and muscles is placed the cellular fabric, in most parts replenished with fat, but in some, as the penis, red part of the lips, &c. it is empty or destitute of fat. There are very few parts in the body of man, where the skin is immediately joined to the muscular fibres, without any separation by fat or cellular substance; but we have an instance of this in the forehead and upon the ears; and though the dartes of the testicle has no muscular fibres, it is not without the cellular substance. There are some places, indeed, where tendinous fibres are inserted into the skin, as in the neck, in the palms of the hands, and soles of the feet.

§ 425. Throughout the whole surface of the skin in most parts of the body, but with some difficulty, you will find it to have a rough appearance after the cuticle is taken off; but in the human body, these are so obtuse, that unless you understand them to be very minute granulations, they are raised hardly any visible height above the skin; but in the ends of the fingers, there are larger round *papillæ* seated in

cavities of the cuticle, and receiving nerves very difficultly seen; namely, a little mount or protuberance formed of small vessels, with one or more small nerves wrapt up together in the cellular substance. These, in the lips and glans penis, after long maceration, appear villous or down-like, and are seen most evidently of all in the tongue, from the fabric of which, we conclude, by analogy, with respect to the other cutaneous papillæ.

§ 426. Over the surface of the skin is placed another covering, which is not so liable to be injured by the air, and which coheres with the subjacent skin, by an infinite number of small bloodless vessels, and by hairs which pass through its substance. The outer surface of this covering, of an horny fabric, is dry, insensible, and not subject to putrefaction; but being destitute of vessels and nerves, it appears in a particular manner wrinkled and scaly. This is called the *epidermis* or *cuticle*, which is perforated by an infinite number of pores, some larger for the sweat, and others smaller for the perspirable vapours, out of whose ducts, expanded and cemented by the interposition of a condensed glue, the substance of the cuticle is probably composed. By pressure or burning, the cuticle grows thicker, by the addition of new plates or scales, formed betwixt the skin and those which lie outermost; and this is called a callus. But even naturally, in blacks, the cuticle has two distinct plates.

§ 427. The inner surface of the cuticle is more soft and like a pulp, somewhat like an
half

half fluid or a concreted mucus; whence, by macerating some time in water, it separates from the former, easily in blacks and tawny moors, but more difficultly in Europeans or white people; for the separation follows in that part, where they differ in colour, as we also see in the palate of brutes. This surface of the cuticle lies incumbent on the skin itself, whose papillæ, in those parts where they are to be found, are received into the soft cuticular alveoli or sockets. This is commonly called *rete Malpighianum*, although it be certain, there are no perforations visible through it, like those of a sieve.

§ 428. That this reticular body is composed of a humour, transuding from the surface of the true skin, seems very probable. As to the fabric of the cuticle itself, it is obscure; for since it is both cast off, or regenerated, insensible, and destitute of vessels, it does not seem to belong to the organical parts of the body. Whether or no it be the outer part of the Malpighian mucus (§ 427.) coagulated and condensed by the air and by pressure, after being perforated with a number of exhaling and inhaling ducts, the mouths of which are cemented together by the interposed condensed glue? and whether or no we are not persuaded to this opinion by the mucous expansion upon the membrane of the tympanum? to which add, the dissolution of it in water, observed by the more eminent anatomists; [which experiment is by others denied in the cuticle of blacks.]

§ 429. Moreover, to the history of the skin, belong the *sebaceous* glandules, both simple and compound (§ 202 to 205), which are seated in many places under the skin in the cellular fabric: from whence perforating the skin by their excretory duct, they pour out a soft half fluid liniment, to oil the cuticle, of an harder consistence in the face, but more oily in the groins and arm-pits, with which the skin being anointed, shines and is defended both from the air and outward attrition; and from these the hairs frequently arise. They are found seated in all parts of the body, that are under a necessity of being more immediately exposed to the air, as in the face, where there are a great number of the compound sort, or wherever the skin is liable to any great attrition, as in the arm-pits, nipples, groins, glans penis, nymphæ, anus, hams, &c. where they mostly send out hairs. If it be asked, whether these follicles are seated in all parts of the skin? we answer, that although anatomy does not every where demonstrate them, yet it seems probable, that they are in no part absent, as may appear from the fordes or mucous filth collected about the whole surface of the body, seemingly of the sebaceous kind. But there is another sort of liniment or oily ointment poured out upon the skin from the fat itself, by its particular pores, without the intervention of glans (§ 202.); and this more especially, where the skin is clothed with hair, as in the scalp.

§ 430. Again, both the *hair* and nails are appendages to the skin. The former are scattered almost over the whole surface of the body, in most parts short and soft, but longer upon the head, mouth, cheeks, and chin, with the breast in men ; also upon the forepart of the limbs, in the arm-pits, groins, and pubes. Of these, the shorter grow out of the skin, but the longer arise with a bulbous root, which is membranous, sensible, and vascular, seated in the cellular substance beneath the skin, wherein the medullary and particular coloured bulb or root is contained. The covering of this root or bulb, filled with a pulp, passes out in a cylindrical figure through a pore, or opening of the skin to the cuticle, which is extended along with it, so as to form a capsule to the hair itself, which, by this means, is rendered permanent and incorruptible ; but beyond the surface of the cuticle, the covering of the hair is not demonstrable, though the spongy and cellular matter be continued through the whole length of the hair. The hairs grow naturally in the cellular substance under the skin, but, by disease, they are sometimes formed within the fat of other parts. They grow continually, and are renewed again, after being cut by a protrusion of their medullary substance from the skin outward, under a production of the cuticle. When the hairs are destitute of this medulla in old people, they dry up, split, and fall off. From the said medulla, the hairs also receive or change their colour. They seem to perspire through their extremities, and possibly

throughout their whole surface, as we may conclude from the constant force of protrusion in their medulla, which, in the plica Polonica, wants a boundary to terminate it. [To which add, the luminous streaks or rays that come out from the hairs of an animal electrified. The subcutaneous fat or oil seems to follow and transude through the medullary tract and pores of the hairs.]

§ 431. The *nails* are of the nature and fabric of the cuticle, like which they are also insensible and renewable, after being cut or fallen off. They are found placed upon the backs of the ends of the fingers and toes, which they support to make a due resistance in the apprehension of objects, having the nervous papillary bodies, that serve the organ of touch, placed under their lower surface. They arise with a square root, intermixed with the periosteum, a little before the last joints, from betwixt the outer and inner stratum of the skin, and passing on soft, go out by a lunar cleft in the external plate of the skin, where the cuticle returns back, and enters into a close adhesion with the root of the nail, together with which it is extended forward as an outer covering. [The nail itself is of a soft tender fabric where it first arises, partly covered by the skin; but, by age and contact with the air, it, in time, hardens into a solid, horny, and elastic body, composed of long hair-like threads, cemented together by interposed glue, and distinguishable from each other by intervening sulci or furrows, by which one may be able to split

split them into a number of lesser orders. The nail thus formed extends itself to the extremity of the finger, and is in this tract lined all along internally within its concave surface, by an expansion of the true skin, and subjacent periosteum intermixed, the filaments of which arise first short, and are afterwards continued of a greater length, 'till they become longest of all at the extremity of the nail to which they cohere. These are most intimately connected into the root of the nail. Over or upon the outer surface of the nail, some part of the skin is again folded, but at liberty and distinct about it. The tendons, however, do not reach quite so far as the nail.

§ 432. The cellular substance is without fat only in a few places, to allow a necessary motion to the skin. Where it is replenished with it, serves to defend the warmth of internal parts from the cold air, to render the skin moveable upon the muscles, to fill up the cavities betwixt the muscles themselves, and to render the whole body white and uniform. The skin, cuticle, and its Malpighian mucus, serve not only to limit the external bounds of the body every where, but likewise where they seem to be perforated, passing inward they degenerate by degrees. For the cuticle is manifestly extended into the anus, urethra, vagina, cornea of the eye, auditory passage, mouth and tongue, nor is it wanting even in the stomach itself and intestines, although, by the perpetual warmth and moisture, its fabric be altered, and extended or relaxed into their villous

villous covering. Thus the true skin is continued into the internal fabric of the palate, tongue, pharynx, nostrils, vagina, &c. where it degenerates always into a white, thick, pulpy, commonly called nervous coat of those parts.

§ 433. What has been hitherto advanced, is sufficient to enable us to understand the nature of touch. The papillæ, seated in the larger winding ridges at the ends of the fingers, regularly disposed in spiral folds, are, by the attention of the mind, a little raised or erected, as appears from frights or shiverings, as we see in the nipples of women, in the handling of tangible objects, and by light friction, whereby, receiving the impression of the object into their nervous fabric, it is thence conveyed, by the trunks of the nerves, to the brain. This is what we call the touch, whereby we become sensible chiefly of the roughness of objects, in which some persons have so sharp a sensation, that they have been known to distinguish colours by touching the surface only. By this sensation we perceive heat, when it exceeds in bodies the heat of our fingers; and weight likewise, when it presses more than is usual. Humidity we judge of by the presence of water, and a softness or yielding of the object; hardness from a yielding of the finger; figure from the limits or rough circumscribed surface; distance from a rude calculation or estimate made by experience, to which the length of the arm serves as a measure; so the touch serves to correct the mistakes of our other senses.

§ 434. The mucus body of Malpighius moderates the action of the tactile object, and preserves the softness and sound state of the papillæ. The cuticle excludes the air from withering and destroying the skin, qualifies the impressions of bodies, so that they may be only sufficient to affect the touch, without causing pain; and therefore, when it is become too thick by use, the sense of feeling is either lost or lessened; but if it be too thin and soft, the touch becomes painful. The hairs serve to defend the cuticle from abrasion, to preserve and increase the heat, to cover and conceal some parts, and render the membranes of others irritable, which nature required to be guarded from the entrance of insects; and perhaps they may serve to exhale some useless vapours. The nails serve to guard the touch, that the papillæ and ends of the fingers may not be bent back by the resistance of tangible objects: at the same time they increase the power of apprehension, and assist in the handling minute objects. In brute animals they generally serve as weapons of offence, and might be of the same use to man, if they were not cut off.

§ 435. But these are not all the uses of the skin, for one most important office of that instrument, is to perspire or exhale from the body a large quantity of humours and other matters, to be carried off by the air. Accordingly, the whole surface of the skin sweats out a vapour, by an infinite number of small arteries, either coiled up into papillæ, or spread on the skin itself, which pass out, and exhale through

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corresponding pores of the cuticle; although the course or direction of the vessels which pour out this vapour be changed in passing from the skin to the cuticle. These exhaling vessels or arteries, are easily demonstrated, by an injection of water or fish glue into the arteries; for then they sweat out from all parts of the skin an infinite number of small drops, which being transfused under the cuticle, rendered impervious by death, raise it up into a blister.

§ 436. In a living person this exhalation is many ways demonstrable. A clean looking-glass, placed against the warm and naked skin, is quickly obscured by the moist vapour. In subterraneous caverns, where the air is more dense, it more plainly goes off into the air, from the whole surface of the body, in the form of a visible and thick cloud.

§ 437. Whenever the motion of the blood is increased, while at the same time the skin is hot and relaxed, the small cutaneous pores, instead of an invisible vapour, discharge *sweat*, consisting of minute, but visible drops, which run together into larger drops, by joining with others of the same kind. But those parts chiefly are subject to sweat which are hottest; that is to say, where the subcutaneous arteries are largest, and have a greater action from their resistance, as in the head, breast, and foldings of the skin. The experiment before mentioned (§ 435.) together with the simplicity of nature herself, joining with the visible thickness or cloudiness of the cutaneous, and pulmonary exhalation (§ 436.) sufficiently persuades us that

that the perspirable matter and sweat, are discharged through one and the same kind of vessels; and differ only by the quantity and celerity of the matter; but together with the sweat is intermixed the sebaceous humour of the glands (§ 427.) and the subcutaneous oil, which being more plentifully secreted, and diluted with the arterial juice, flows out of an oily and yellow consistence; and chiefly gives that smell and colour to the sweat for which it is remarkable. Hence we find it more foetid in the armpits, groins, and other parts, where those glandules are most numerous or abundant.

§ 438. Concerning the nature of *perspiration*, we are to enquire by experiments, and by analogy, with the pulmonary exhalation, which more frequently and abundantly perspires a vaporous cloud of the same kind, more especially visible in a cold air. That what flies off from the body in this exhalation is chiefly water, appears from experiments, by which the breath being condensed in large vessels, forms or gathers into watery drops. Agreeable with this, we find the obscuring vapour condensed by a looking-glass, to be extremely subtle, so as wholly to fly off again from it; and the same is confirmed by the obstructed matter of perspiration passing off by urine, or frequently changing into a diarrhoea; and from the easy passage of warm liquors in the form of perspiration, by a hot air; or else by the urinary passages in a cold air. The water of these vapours is chiefly from what we drink, but is in part supplied

supplied from the inhalation of the skin. Frequently, even the particular smell of the aliments may be plainly perceived in the perspiration.

§ 439. But that there are besides water some volatile particles intermixt, of an alkaline nature, is evident, as well from the nature of our blood, with the skilful distinction which dogs make of their masters by the scent, and the considerable mischiefs which evidently follow in acute diseases from a retained perspiration; how frequently does it turn inwards, so as to cause a paleness of the urine, or else corrupt the air externally, and spoil it for respiration? This volatile alkaline matter arises from the finer particles of the blood, attenuated by perpetual heat and triture, and changed into an acrimonious nature. These afford the scent, which is closely followed by dogs; and these form the electric atmosphere, which is frequently seen luminous about men and other animals.

§ 440. The quantity of our perspiring moisture, is very large, whether we consider the extent of the organ, by which it is separated, the abundance of vapours derived from the lungs only; or barely take a review of the experiments made by Sanctorius, in which five [others say three and four] pounds out of eight of the food and drink taken into the body in a natural day, were found to fly off by perspiration only, exclusive of any of the visible discharges, and without making any addition to the weight of the body. But the cutaneous exha-

exhalation is even much larger than this; since it not only throws off such a quantity of the indigested food and drink, but likewise what is added to the blood by the way of inhalation (§ 444.) which entering often in a very considerable quantity, is thus again expelled. But different dispositions of the air, and of the human body, cause great variations in those matters. In warm countries, in the summer months, and in young exercised persons, more goes off by transpiration from the body, and less by the urine. But in cold climates, during the temperate or winter seasons, in aged or inactive persons, more goes off by the urine than by the insensible discharge, which is likewise the case in temperate climates, and seasons: but even there, with animal food, and fermented drinks, the perspiration exceeds the urine. The difference of time after feeding does also in some measure vary the quantity transpired; but in general it is most copious at that time when the greater part of the digested nourishment is conveyed into the blood, and therewith attenuated so as to be fit for exhalation. It is naturally diminished in sleep, even in the warmer climates, unless it be increased by the heat of bed-clothes.

§ 441. In general, a plentiful and uniform perspiration, with strength of body, are good signs of health; for whenever it abounds from too great weakness, it is observed to do more mischief than none at all. It is thus a sign of health, because it denotes a free pervious disposition

position of the vessels, dispersed throughout the whole body, together with a complete digestion of the nourishment, the greater part of which is perfectly attenuated into a volatile or vapory disposition. When it is diminished, it indicates either a constriction of the skin, a weakness of the heart, or an imperfect digestion of the aliments. Perhaps in too great a perspiration the nervous spirits themselves are evaporated. This discharge is, by moderate exercise, encreased to six times that of an idle person, even to an half or whole pound in an hour, aided by strong and open vessels, by warm, watery and vinous drinks, with animal food of an easy digestion, and a heavy, temperate or moderately warm air, assisted with joyful affections of the mind. The contrary of these either lessen or suppress the perspiration. However, the continuance of life does not depend on a scrupulous exactness in the quantity of this discharge, which is so easily increased or diminished by slight causes; which is shut up by paints, in many *Indian* nations, and is inconsiderable in many animals, without any sensible injury.

§ 442. The sweat is evidently of a saline nature, as appears both from the taste, and from the minute chrystals which appear to shoot upon the cloaths of such as work in glass-houses; as well as by distillation, which shows the sweat to be of an alkaline nature. Hence it is, that by this discharge, the most malignant matter of many diseases is thrown off from the body. But in reality, sweat is always a preternatural

natural or morbid discharge, from which a person ought always to be free, unless by violent exercise, or other accidents, his constitution is for a short time thrown into a diseased state. Nor is it unfrequent for sweats to do considerable mischief in acute diseases, by wasting the watery parts, and thickening the rest of the blood, at the same time that it renders the salts more acrimonious. By a too violent motion of the blood, the sweat is rendered extremely fetid; and is sometimes even red, or mixt with blood itself; being electrized, it sometimes is lucid.

§ 443. The uses of perspiration are to free the blood from its redundant water, and throw out those particles, which by repeated circulations have become alkaline, or otherwise acrimonious, and possibly to exhale therewith an extremely volatile oil, prepared from the same blood. The same perspiration likewise qualifies and softens the cuticle, which is a necessary medium, extended before the tender sensible papillæ.

§ 444. But the same skin that makes this exhalation into the air, is likewise full of small vessels, which inhale or absorb thin vapours from the air, either perpetually, or at least when it is not very cold; more especially when the air is damp, the body unexercised, the mind oppressed with grief, or both under conditions contrary to those which increase perspiration before mentioned (§ 430.) These veins are demonstrated by anatomical injections, which if thin or watry, sweat through them in

the same manner as through the arteries (§ 435.); moreover, the manifest operation of medicines in the blood, which were exhaled into the air, or applied to the skin, prove the same; such as the vapours of mercury, turpentine, saffron, Bath-waters, mercurial plasters, tobacco, coloquintida, opium, cantharides, arsenic, with the fatal effects of contagious or other poisons entering through the skin; as in the venereal infection; to which add the living of animals, almost without drink in hot islands, which abound with moist vapours, from which, however, they sweat and piss plentifully enough. Lastly, some extraordinary morbid cases have demonstrated this, in which a much greater quantity of urine has been discharged than the quantity of drink taken in. The proportion of this inhalation, is difficult to assign; but that it is very great in plants, more especially in the night-time, appears evidently from certain experiments which may be seen in the vegetable statics of Dr. Hales.

§ 445. These cutaneous vessels both exhaling and inhaling, are capable of contraction and relaxation by the power of the nerves. The truth of this appears from the effects of passions of the mind, which if joyful increase the circulation, and relax the exhaling vessels, so as to yield easier to the impulse of the blood; from whence, with a shortening of the nerves, there follows a redness, moisture, and turgescence of the skin. Those passions, on the contrary, which are sorrowful, and retard the circulation,

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on, contract the exhaling vessels, as appears from the dryness and corrugation of the skin, like a *goose-skin* after frights; and from a diarrhæa caused by fear. But the same affections seem to open and increase the power of the inhaling vessels, whence the variolous or pestilential contagions are easily contracted by fear.

LECTURE XV.

Of the Taste.

§ 446. **F**ROM the sense of touch, and its organ, there is but a small difference or transition to that of the *taste*; which appears by certain experiments to be seated in the tongue chiefly; for even the most relishing bodies applied to any other part of the mouth are hardly more than felt, exciting scarce the least sense of taste in the mind, if they are not uncommonly acrid and penetrating: and even that sense which is sometimes occasioned in the stomach, œsophagus and fauces, from a rising of the aliments, seems also to be owing to the tongue, to which the tastable vapours are conveyed.

§ 447. Only the upper and lateral edges of the *tongue* are fitted to exercise the sense of taste. But by the tongue we understand a muscular body, broad and sulcated in man, and lodged in the mouth, whose posterior and lower parts are variously connected to the adjacent bones and cartilages, while it remains moveable in its anterior and upper part. In those portions of the tongue, which make the organ of taste, the skin grows to the adjacent muscular fibres, being continued from the skin of the face and mouth, only here it is always soft and pulp-like, from the perpetual warmth and moisture. From this skin of the tongue arise
innu-

innumerable *papillæ*, of a more considerable bulk here than in other parts. Of these there are several kinds: the first of them are disposed in a rank on the back part of the tongue, on each side the foramen cæcum. These, surrounding that opening like a circle, are for the most part conical, having a deep sinus in their middle, but are otherwise hard, and but indifferently disposed for tasting. There are some other *papillæ* of the same kind found scattered before these upon the back of the tongue.

§ 448. The other kind of *papillæ* are like mushrooms, less and slenderer than the former, of a very cylindric, and somewhat oval figure, placed at some small distances from each other, upon the upper surface of the tongue, where they grow sharper pointed, as they lie more forwards, and are most numerous on the sides of the tongue. The third sort of *papillæ*, which abound most in number, are spread largely over the tongue, betwixt the former, with their apices somewhat inclined and fluctuating before, towards the tip of the tongue; and these which are likewise most numerous in the sides of the tongue, are highly sensible, and make the true organ of taste: as for the intermediate, arterial and venal pile, or villi, which serve for exhaling and inhaling thin juices, they have nothing in common with the taste itself, unless that by separating and pouring out a thin juice from the blood upon the back of the tongue, they conduce to soften the *papillæ*, and dissolve the saline or sapid particles. [In the upper and back part of the tongue, are seated many round

simple muciferous glandules, furnished each with one or more out-lets, completed either by an hemispherical membrane, or by the flesh of the tongue. Some of these open into an obscure foramen, or rather *antrum cæcum*, of an uncertain figure, and seated in the midst of the largest nipples of the tongue, § 448.]

§ 449. These papillæ have doubtless small nerves detached into them, besides numerous vessels, although they are difficult to trace; for we observe, that larger nerves go to the tongue, than almost in any instance which we have in other parts; for besides the nerve of the eighth pair, which being one of the principal of the three branches, enters the basis of the tongue, deeply covered by the cerato-glossus, near the os hyoides; there is also a considerable nerve that goes to the tongue, and its muscles, from the ninth pair, which having inosculated with the first nerve of the neck, and with the large cervical ganglion, it sends a branch downward, and frequently joins the eighth pair; but constantly communicates with the second and third of the neck, from whence its branches ascend to the muscles arising from the sternum; and frequently communicate with the phrenic nerve; after which the rest of its trunk goes to the tongue. This communicates, by many branches, with the fifth pair in the cerato-glossus, and is more especially spent in the genio-glossus. Lastly, the third branch of the fifth pair having sent up or received the cord of the tympanum, and given other branches to the internal pterygoides, with the maxillary and

sublingual glands, passes with its principal trunk behind the cerato-glossus, where it joins the ninth pair, and enters the tongue, deeply in company with the artery; together with which it is extended to the tip of the tongue, where it becomes cutaneous. To this nerve, therefore, if there be any prerogative or preference, the sense of taste is to be more especially ascribed. [Lastly, the nipples or papillæ of the tongue are of a hard texture, each papilla having its pulpy fabrick made up by a number of small nerves, arteries, and veins, conjoined or wound up together into a button, or protuberance, by a firm cellular substance.]

§ 450. Over the papillæ of the human tongue is spread only a single mucous and semipellucid covering, which strictly adheres to them, and serves them as a cuticle. But in brute animals, a perforated mucous network receives the papillæ, which are in a manner wrapped up in cases or capsules of this mucous body covered with the cuticle.

§ 451. Under those papillæ are spread the muscles which make the fleshy body of the tongue; which are very numerous, and hardly extricable in the human tongue: in the lower part, it is in a great part made up of the genio-glossus muscle, extended outwards, from the meeting of the chin, and distributed like rays into the substance of the tongue. The upper and lateral parts are composed by the stylo-glossus, whose fibres run to the tip of the tongue; which in its middle part, betwixt the former muscles, is composed of one proper to itself,

called *lingualis*, which arising from before the pharynx and origin of the stylo-glossus, only lower, goes out forward, and terminating betwixt the said genio-glossus and stylo-glossus, makes up a very considerable part of the tongue. The back part of the tongue is made up of the fibres of the cerato-glossus, which ascend upward and backward; and by the fibres of the cerato-glossus, a muscle distinct from the former, which arises from the small bones, and next adjacent basis of the os hyoides; from whence passing outward, with its lateral portions, covered by the genio-glossus, it joins the stylo-glossus, and disappears in the tongue. By the action of these muscles, the whole tongue is moveable in all directions, and capable of figuring its own substance, so as to form a hollow, by the elevation of the stylo-glossi, which it again flattens by the cerato-glossi, but contracts itself into a narrow and almost cylindrical figure, by the transverse fibres from one side to the other, together with which there are many other orders of fibres, intermixt with a thick fat; so that they cannot be traced in the human tongue.

§ 452. The arteries of the tongue are numerous; one that is larger and deeper ascends in a serpentine course from the outer carotid, and extends to the tip of the tongue; and a lesser superficial artery, incumbent on the sublingual gland, either arises from, or inosculates with the preceding; or else there are various small branches derived from the posterior labials; and from the branches proper to the lips,
or

or those of the tonsils. The veins of the tongue are variously wove, and difficult to describe; some of which lying deep, accompany the nerve of the ninth pair; and others that are superficial accompany the mental artery, and inosculating with the former, sends out the ranular vein; but all of them meet together in a large vein, which is one branch of the internal jugular coming from the brain. These veins variously communicate with the adjacent complications or net-works belonging to the tonsils, pharynx, thyroid-gland and skin; and in the back of the tongue, before the epiglottis, there is a communication betwixt the right and left side of the venal plexus.

§ 453. The *papillæ* of the tongue, which are larger and softer than those of the skin, perpetually moist, perform the office of touch more exquisitely than those of the small and dry cutaneous papillæ; and from hence the tongue is liable to a sharper degree of pain: moreover naked salts are not otherwise perceived than under a sense of moisture or of pain. But the papillæ of the tongue being raised a little protuberant, to perform the office of taste, from salts dissolved in water, or saliva, and applied against their tips or summits, are affected in a particular manner; which being distinguished by the mind, and referred to certain classes, are called flavours or *tastes*, either sour, sweet, rough, bitter, saline, urinous, spirituous, aromatic, or pungent and acrid, with others of various kinds, resulting partly from pure salts, and in part from an intermixture of the subtle animal,

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animal; or vegetable oils, variously compounded and changing each other; but all caustic salts, or such as are acrid in a high degree, excite pain instead of taste. If it be enquired, whether the diversity of flavours arises from the different figures which are natural to salts? and whether this does not appear, from the cubical figure in which sea-salt shoots, the prismatical figure of nitre, or the particular configuration of vitriol, sugar, &c.? We answer, that this does not seem probable, for even tasteless crystals have their particular configurations; and the taste arising from very different salts, and differently qualified objects of this sense, are too much alike each other, and at the same time too inconstant or changeable to allow such a theory; as for example, in nitre. The mechanical reason, therefore, of the diversity of flavours, seems to reside in the intrinsic fabrick or apposition of their elements, which do not fall under the scrutiny of our senses.

§ 454. But the nature or disposition of the covering with which the papillæ are cloathed, together with that of the juices, and of the aliments lodged in the stomach, have a considerable share in determining the sense of taste; in so much, that the same flavour does not equally please or affect the organ in all ages alike, nor in persons of all temperatures; nor even in one and the same person at different times, who shall be differently accustomed in health or variously diseased. In general, whatever contains less salt than the saliva itself, seems insipid.

§ 455. The spirituous parts, more especially of vegetables, either penetrate into the papillæ themselves, or else are absorbed by the adjacent pile or villi of the tongue, as may appear from the speedy recruital of the strength by vinous or aromatic liquors of this kind, even before they are received into the stomach.

§ 456. Nature designed the difference of flavours to be felt by the tongue, that we might know and distinguish such foods as are most salutary ; for in general, there is not any one kind of aliment healthy, that is of a disagreeable taste ; nor are there any ill tasted that are fit for our nourishment. For it must be observed, that we here take no notice of excess, by which the most healthy food may be prejudicial. In this manner nature has invited us to take necessary food, as well by pain called hunger, as by the pleasure arising from the sense of taste. But brute animals, who have not like ourselves the advantage of learning from each other by instruction, have the faculty of distinguishing flavours more accurately, by which they are admonished to abstain cautiously from poisonous or unhealthy food ; and therefore it is, that herbivorous cattle, to which a great diversity of noxious plants are offered amongst their food, are furnished with such large and long papillæ, of so elegant a structure in the tongue, of which we have less need.

LECTURE XVI.

Of Smelling.

§ 457. **T**O the same use, likewise, of distinguishing prejudicial from salutary food, the sense of smelling conduces, by which we even discern and are admonished to avoid, before it comes either to our touch or taste, to which it might be otherwise dangerous, when of a malignant nature; although continual practice even in this faculty, has also rendered it more useful and accurate among brute animals than in ourselves. For men who have been brought up wild by themselves, without debauching the scent by a variety of smells, have been observed not to make any difficult choice in gathering herbage or aliments for their food. Finally, the powers and virtues of medicinal plants, are hardly to be better known than by the simple testimony of tasting and smelling. From hence it is, that in all animals these organs are placed together; and from hence the smelling is stronger, and the organs larger, in those animals which are to seek their prey at a considerable distance, or to reject malignant plants from among those that are fit for food.

§ 458. The sense of smelling is performed by means of a soft pulpy membrane, full of pores and small vessels, which lines the whole internal cavity of the nostrils, being thicker upon the septum and principal convolutions, but thinner

thinner in the sinusses. Within this membrane are distributed abundance of soft nerves throughout the middle of its fabric, from the first pair, (§ 371.) which descend through the holes of the os cribrosum into the septum narium, but, in such a manner, that it is very difficult to trace them to their extremities and into the septum. Other lateral nerves come from the second branch of the fifth pair, in company with the blood-vessels, and some from the infra-orbital-branch in the maxillary sinus. Moreover, the fore-part of the septum has a small twig from the ophthalmic of the first branch belonging to the fifth pair.

§ 459. The arteries, which go to the nose, are many, several from the internal maxillary branches, from the three nasal ones, to wit, the upper and the lateral, from the ophthalmic branch of the internal carotid, from branches of the palatine artery, and from the infra-orbital within the sinusses. The veins run together in company with arteries, and form a large plexus, by uniting upon the external pre-rygoide muscle, and communicate with the sinusses of the dura mater; from whence they open together into the outer branch of the internal jugular. The said arteries supply the nourishment, warmth, and mucus, necessary to these parts.

§ 460. The necessary reduction of the human head, to that of a round figure, has in us given, to the organ of smelling, but a small extent of surface; but to enlarge this the more, nature has made the internal parts of the nose variously

variously hollow and complicated. First then, by the *nares* or internal nose, we understand the multiform cavity, which begins before from the nostrils, and, extending transversely backward, over the roof of the palate under the *os cribrosum*, terminates at the cavity of the fauces. This cavity is divided into two, by a *septum* or partition of bone, which descends above from the plate of the *cribrosum*, but below is formed by the vomer, and in its fore-part is completed by a triangular cartilage, whose surface is largely extended and very sensible.

§ 461. Moreover, the lateral surfaces of the nares are increased by the spiral volution of the *ossa turbinata*; the uppermost of which are small turns or folds of a spiral figure, from the upper part of the *os cribrosum*. The middle fold belongs to the same, somewhat oblong like a conch or shell, internally convex, externally concave, rising into an edge on each side, and all over rough with little sinuosities or excavations, and inwardly filled with spongy cells or recesses; the whole being suspended in a transverse position, and supported or propped by particular eminences in the bones of the palate and upper jaw. The lowermost turbina, somewhat like the middle ones, do like them resemble the figure of a muscle-shell, but longer; for the most part distinct or divided from the former, but sometimes conjoined by a bony plate, which is most frequently of a membranous nature. This bony appendix,
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being extended upwards in a square form, serves to complete the maxillary sinus.

§ 462. From hence the cavity of the nares is enlarged or dilated by various sinusses, which are a sort of recesses or appendages to the whole. And first, the frontal or uppermost sinusses, which are not always present, are of an irregular figure, intercepted betwixt the anterior and posterior plate of the frontal bone, where it forms the superciliary protuberances; and these, being not found in a foetus, seem to arise from the action of the corrugator and other muscles, which draw the anterior plate of this bone outward, so as to increase the diploe into large cells, in the same manner as we observe in the mastoide process, from the like cause. These open in the upper part of the nares, into the anterior cell of the os papyraceum.

§ 463. In the second place come the *ethmoidal sinusses*, which are four or more, on each side, in the outer part of the os cribrosum, like the cells of an honey-comb, completed above by the cellular or spongy middle part of the os frontis, and before by the os unguis; from whence they open by many small tubes, in a transverse position, into the upper part of the nares. With these are continuous the cells in the pavement or bottom of the *orbit*, and those engraved in the os planum and maxillare, are continued from them outward. In a third place, this sinus is contiguous on each side with the cavity or *sinus of the multiform bone*, extending largely on each side towards the os cribrosum

cribrosum and palatinum, which is itself formed, in a dry preparation, by a cartilage of large extent in the foetus, and by a solid bone, which gradually widens under the integuments, with an ample cell, either single or divided, and opening forward, by its aperture or foramen, into the superior part of the meatus narium.

§ 464. The last, lowermost, and biggest sinus, which, in a foetus, is inconsiderable, but, in an adult, very large, is that formed in the bone of the *upper jaw* by several thin bony plates. The opening of this into the nose, is betwixt the os unguis, bone of the palate, and the proper lamella or plate, which accedes to it from the bottom of the os turbinatum. Which opening is so much lessened by the surrounding membranes, as to form only a moderate round aperture in the space betwixt the middle and bottom of the os spongiosum.

§ 465. The nerves of the nose, being almost naked, required a defence from the air, which is continually drawn through the nostrils by the use of respiration; nature has, therefore, supplied this part, which is the organ of smelling, with a thick insipid mucus, very fluid in its first separation, and not at all saline, but by the air, condenses into a thick dry crust, more consistent here than in other parts of the body. By this mucus, the nerves are defended from drying, and guarded from pain. It is poured out from many small arteries of the nostrils, and deposited partly into numerous cylindrical ducts, and partly into round visible criptæ or cells; from whence it flows out all over

over the surface of the olfactory membrane, which is therewith anointed on all sides. In the septum, runs down forward a long sinus to a considerable length, which is common to many muciferous pores: this mucus is accumulated in the night time, but in the day expelled by blowing the nose, or sometimes more powerfully by sneezing; and may offend by its excess or tenuity, or irritate, by too great thickness, the very sensible nerves; from whence a sneezing is excited for its removal. But the sinusses of this part, which abound with mucus, are this way variously evacuated, agreeable to the different postures of the body, by which always some of them are at liberty to free themselves, whether the head be erect, or inclined forward or laterally; yet so, that generally the maxillary and sphenoidal sinusses are more difficultly emptied than the rest. Moreover, the tears descend, by a channel proper to themselves, into the cavity of the nose, by which they moisten and dilute the mucus.

§ 466. To the extreme parts of the nares or organs of smelling, is prefixed the nose, lined inwardly with a membrane of the same nature, composed of two bones and usually six cartilages, two of which are continued together into the middle septum (§ 240.) These cartilages render the nose moveable by its proper muscles, so as to be raised and dilated by a muscle common to the upper lip, and to be contracted together into a narrower compass, by the proper depressor and compressor muscle pulling down the septum. Thus it forms an

air-engine, which, for the reception of smells, can take air in a larger quantity by dilating, then contracting again by elasticity, when the air is afterwards abundantly thrown out.

§ 467. The air, therefore, filled with the subtle and invisible effluvia of bodies, consisting of their volatile, oily, and saline particles, is, by the powers of respiration (§ 282.) urged through the nose, so as to apply the said particles to the almost naked, and constantly soft olfactory nerves, in which a kind of feeling is excited, which we call *smelling*; and by this sense, we distinguish the several kinds of oils, salts, and other matters, difficultly reducible to classes, which hereby we perceive indistinctly; whence they are difficultly recalled to memory, though the odours, already established, are sufficient enough for our purposes. This sense serves to admonish us of any pernicious putrefaction, of any violent acrimony, or of a mild, soapy, and useful disposition in bodies. And as salt, joined with an oil, is the object of taste, so a volatile oil, aided with salts, serves to excite smells; whence the affinity of the two senses, which conjunctly assist and move each other, may be easily understood. But the particles, which excite smell, are more volatile, as those, belonging to the taste, are more fixed, whence the difference in these organs may possibly consist in the thick mucous cuticle, which, being spread over the tongue, intercepts the action of the more subtle saliny effluvia from acting upon the taste, which yet
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easily effect the softer and less covered nerves of the internal nose.

§ 468. Smells have a very strong action, but of short continuance; because they are applied immediately, by the most minute particles, to nerves which are very near to the brain itself, and almost naked; from thence too proceeds the force of poisonous vapours, and the refreshment from agreeable odours, by which some persons are effectually recalled to themselves out of a dead swoon, or even after drowning. From hence comes that violent sneezing, which often arises from acrid particles; and a looseness or purging of the bowels, from the smell of some medicines, with the power of particular antipathies. From hence is derived the pernicious effects of excessive sneezing, more especially blindness from the near consent or society of the nerves. But amongst the various parts of the nose, the septum, and more especially the os turbinatum, have a considerable share in the organ of smelling: since these are parts multiplied in quick-scented animals, so as to form beautiful spires in hounds and other quadrupedes; and in fish, who smell by water, they are formed like the teeth of a comb, in an elegant manner,

LECTURE XVII.

Of Hearing.

§ 469. **A**S the sense of smelling distinguishes the small bodies which float in the air, so that of hearing perceives the elastic tremors or impulsions of the air itself. Therefore, we observe the sensitive organ of the ear to be composed in a different manner from that of any of the other senses, as it is made up, for the most part, either of hard bones or elastic cartilages and membranes, which are the most exquisitely enabled to receive and communicate the necessary tremors.

§ 470. The external part of this organ, called the *auricle* or outer ear, is a cartilaginous funnel, connected, but with a sort of mobility, before and behind, to the bones of the temple, by means of a strong cellular plate, and likewise by its own proper ligaments and muscles. This cartilage is of a very compound figure, the outer eminence of which, called *helix*, begins above by a loose tape, is carried round at liberty about the edge of the upper part of the cartilage, upon the posterior side of which, it terminates in the same loose manner. Within the body of the cartilage, surrounded by the former, arises a double or bifurcated eminence, meeting together in one called the *anthelix*, which terminates in a small and short tongue or protuberance, called the

the *antitragus*. The remaining part of the ear, called the *concha* or shell, is before hollow, behind convex, growing gradually deeper, with a crooked line or ridge running through its middle, under the denomination of the *concha*, which is immediately joined with the *meatus auditorius*, before which stands a round moveable appendix of the cartilage, as a defence, called the *tragus*. This whole cartilaginous body of the outer ear is only surrounded by the skin, which is thin, and by the cellular substance which is empty ; and is replenished with many sebaceous glandules, which supply an ointment. This part is governed or directed by certain muscles, which generally lose their use and action from the custom of binding the head in children, which we are otherwise to suppose they were designed by nature to perform. The uppermost of these muscles arises thin from the frontal and from the aponeurosis of the cranium ; whence it is broadly spread over the aponeurosis of the temple muscle, and is inserted into the ear, at the side of the anonymous cavity. The posterior muscles, which are two or three, more or less, are more robust than the former in a transverse position, and, arising from the same aponeurosis, are inserted into the convex part of the conch near the mastoidal bone ; the cavity of which conch, they, doubtless, are designed to open or enlarge. The anterior muscle is one of the least, which, being spread upon the aponeurosis of the temporal, is inserted almost transversely into the origin of the helix. But

the lesser muscular portions, which, though short, and not very conspicuous, look of a red colour, are probably of use to make some change in the figure of this part. The transverse muscle of the outer ear, which, for a long way, conjoins the helix with the antihelix, serves to open the auricle. The antitragic muscle, descending from the root of the antihelix to the antitragus, serves to relax or widen the entrance of the conch. The tragus, which lies upon the tragus, dilates or opens the entrance to the auditory passage; and the small muscle of the larger notch or incisure, that lies betwixt the two cartilages of the auditory passage, forming the tragus and antitragus, serves to bring them nearer together, and to render the meatus itself more tense and elastic. The remaining muscles, the longer or larger and the lesser of the helix, have hardly any great use, unless it be to tighten or brace up the cartilages, whenever we attend or listen to the hearing of weak sounds; and, by drawing together the cartilages, they likewise render the auditory passage more firm and tremulous.

§ 471. To the concha is connected the *meatus auditorius*, somewhat of a round compressed figure, lessening as it bends inward, for a considerable part bony, and bent forward in its middle. But, in its anterior and outer part, it is, in some measure, made up by three imperfect rings, arising from the concha and tragus, and united together, and to the bone itself, by intermediate flesh, membrane, and cartilage. Upward and backward, the meatus

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is completed by a mere membrane. This is the state of it in adult persons ; for in the foetus and new-born infants, the meatus is wholly cartilage, and becomes afterwards, in part, a bone by degrees.

§ 472. Through the auditory passage, are continued the cuticle and true skin, gradually extenuated and exactly stretched over the surface of the bone, by which it is rendered extremely sensible of any itching pleasure or pain, and, being replenished with irritable hairs, is, by them, admonished of any sordes or wax abounding, and guarding from the entrance of small insects. But, in the cellular substance under the skin, which is here more firm, and makes up the greater part of the membrane (§ 471.), in a sort of reticular manner, are seated numberless round follicles or cells of a yellow colour, which pour out their contents by short ducts into the cavity of the auditory passage ; at first of an oily consistence, but afterwards it becomes more thick, bitter, and inflammable like wax. This liniment defends the sensible skin and membrane of the tympanum from injuries of the air, and keeps out or catches any small insects ; but, when accumulated in too great abundance in those, who are slothful or uncleanly, it may be the cause of deafness, or a difficulty of hearing.

§ 473. Into this described cartilaginous funnel of the ear, the sonorous waves of the air flow, which, from principles of mechanics, it must, of course, collect together. The elastic

tic air only receives sonorous tremors or impulsions, and transfers them, either alone or principally, much after the same manner as we see water, without air, transfer any impulse that is given to it. From hence, the foresaid sound is encreased in air that is condensed, and is lost in a vessel emptied of its air. But the medium receives these tremors, either from some body striking against it, or from the air itself colliding against another body, or lastly, from the collision of two bodies against each other in the air. But the body, which produces sound, ought to tremble or vibrate in all, even the least of its particles. From such a tremor, the contiguous air is beat into waves, whereby the parts of the air, that lie outermost, are compressed and fly back again, so soon as their elasticity gets over the impulse, whence the air flies again towards the sonorous body, where it is now more loose and rarified, to be there again compressed by impulsion; and in the same manner, the anterior and outer portion of air, surrounding that which is impelled, is, by the action of the latter, compressed and removed farther from the trembling body, yet so as to return again in its proper time by the force of elasticity, driving its contents to the tremulous body for the exciting of a new wave. These oscilations or impulsions of the air are required to succeed each other with a certain velocity; and, in order to render them audible, they must not be fewer than thirty in a second of time. But as these sonorous waves are more frequent in a given time, so much sharper is

is the sound heard, and the more strongly does it affect us, 'till we come to the most acute of audible sounds, which have 7520 tremors in a second.

§ 474. Acute sounds are, in general, yielded from bodies that are hard, brittle, and violently shook or struck; but grave sounds are from the contrary. As to any medium betwixt acute and grave sounds, there is none but what is arbitrary. Cords, or other bodies, that yield the same number of vibrations in a given time, are said to be *unison*; as those which make double the number of oscillations in that time, are said to yield a tone that is an octave or eight notes higher; and other proportions betwixt the numbers of the vibrations, have different names assigned to them in a musical scale. The shorter cords produce sharper tones, and the reverse, in a proportion directly as their lengths; as those, which are more stretched, afford sharper sounds in a subduplicate proportion to their tenuity, or to the weights, or powers by which they are stretched, as one may easily perceive, by experiment, either in a violin or monochord.

§ 475. The sound, thus produced, whether acute or grave, strong or weak, is carried through the air with a celerity equal to about 1038 Paris feet in a second, and that with a uniform velocity, without abating in the larger distances. But a contrary wind, causing the vibrations to extend more slowly, retards the progression of sound about $\frac{1}{12}$ of its velocity. So likewise density and dryness of the air increase

crease the sound, as a rarefaction and moisture of the air lessen it. Hence, in summer time, sounds move swifter; and in Guinea, it has been observed to pass at the rate of 1398 Parisian feet in one second of time.

§ 476. The sound, thus every way extended, meets with certain particles in all adjacent bodies, even in water and mercury, to which it communicates similar tremors or vibrations, not only such as are in unison with the original tone, and which yield a sound, in a more particular manner, sensible, but also it excites tremors less sensibly, even in the other parts of bodies, which vibrate in the various proportions of the scale. From hence it is, that every sound, which we hear, is a mixture of the original tone, produced by the trembling body in conjunction with secondary tones generated from the elastic tremors of the surrounding bodies. The strength of sound is increased, if one audible or primary tone follows the other so closely, that their succession cannot be distinguished by the ear; but if they follow each other so slowly as to be distinguishable by the ear, they produce an echo; but to produce this, requires an interval of six parts of a second of time, or the distance of 110 feet betwixt the reflecting or echoing body and the ear.

§ 477. Sounds, being elastic, are reflected from hard bodies in angles, equal to those of their incidence. But the same sound, ushered into the open air, and dilating through an immense sphere, grows proportionably weaker; but

but if it be ushered through a tube, in a cylindrical shape, the strength of it is more confined together, or else, by being collected into the focus of a parabola or ellipsis, it becomes increased, as we observe in speaking trumpets; from which the voice goes out parallel to the focus of the parabola, without scattering the sonorous rays.

§ 478. Therefore the sonorous waves of the elastic air, being driven into the cartilaginous funnel of our ear, which is naturally inclined forward and outward in an high situation, are repelled and collected together, by alternate reflections from its elastic sides, into the cavity of the concha, from whence it proceeds thro' the auditory passage, with a force so much stronger, as the surface of the outer ear is larger than the light or section of the said auditory passage, through which, however cylindrical, the same force is continued entire forward, and increased by new resonances, excited from the percussion of the elastic cartilages and hard bones, so as to mix imperceptibly with the primitive sound.

§ 479. Moreover, the bottom or end of the said auditory passage is terminated internally by a thin membrane, called the *membrana tympani*, which, in adults, is of a roundish figure, and placed with an obliquity; but so, that, from its upper appendix, it projects inward like a shield, whilst the part, which lies above its middle, projects into the cavity of the meatus like a shield. This membrane of the tympanum is composed of several plates, the first or
outer-

outermost of which is white and mucous; the other is a true skin, continued from the membrane of the meatus, and replenished with small nerves and blood-vessels; the third is a dry, rattling, splendid, and pellucid membrane or plate, without blood-vessels; and the innermost is the vascular periostium of the tympanum. This membrane is not naturally perforated with any opening, so far as I have been able to discover. It is constantly so stretched in the sulcus or groove of the bony ring, in which it is contained, that there is no part of the human body to be found more tense or more tremulous than this. Upon the surface of this membrane, and more especially upon its conial cavity pointing inward, the sonorous waves strike, after they have received their last reflections from the auditory passage, by which the elastic fabric of this membrane is forced into oscillation.

§ 480. The foresaid membrane is stretched over a cavity of the os petrosum, called the *tympanum*, which is, for the most part, of a roundish figure, but not regularly so; being divided in its middle into two by a promontory, and in the adult, is increased backward by the cells of the mastoide bone, which are absent in the foetus. But also, in its upper and anterior part, the tympanum has hollow cells, and is lined with a vascular membrane, receiving small branches from the internal carotid, and from a branch of the artery of the dura mater, which last passes through a fissure in the aqueduct, and it has others from the external arteries

ries of the tympanum and from the stylo-mastoidea. It is commonly full of a mucus, poured into it from the Eustachian tube, and is divided by various membranes into a kind of cells.

§ 481. Within this cavity, three of the larger *bones of hearing*, together with a fourth, which is less, are suspended moveably. And first, the *malleus* or hammer, lies with its upper round head resting upon the concavity of the tympanum, from whence the handle of it is extended down, across the membrane of the tympanum, betwixt the innermost plate of it that lies next the tympanum and the internal dry plate before-mentioned (§ 479.), till, having reached as low as the middle of the membrane, it terminates by a very close cohesion, with a broad extremity a little incurvated outwards. The same bone is, moreover, connected and sustained by a peculiar ligament of its own, joining it to the longer leg of the incus; and another membrane serves as a security near the longer process of the malleus. This bone drives outwards the membrane of the tympanum, which is spread over the shorter and conical process of its handle. From the same place of this bone a broad, long, and flat process, goes out forward into a sulcus of the tube. It is articulated with the incus by two heads, having protuberant lines with a sulcus in the middle, and all of them oblique.

§ 482. In the malleus, are commonly described three muscles, the first and internal of which,

which, called *tensor tympani*, being the largest, is lodged in a particular groove within the tube, with which it proceeds parallel, and bending round a pully, is inserted by its tendon outward into the beginning of the handle. The *second* muscle arises from a fulcus, but externally in the same tube, is shorter than the former, and carried back almost in the same manner, but without being reflected, it adheres by a considerable extent to the longer process. The *third* muscle of the malleus, which arises from the auditory passage, passes through a notch in the broken or interrupted ring of the tympanum, and is inserted just by the shorter process into the malleus; and this, which is, by some, said to relax the membrane of the tympanum, has never been found or seen neither by myself, nor by many other eminent anatomists. For the rest, by means of the tensor of the malleus, the membrane of the tympanum is disposed for the hearing of weak sounds; as the other muscle serves to moderate in two violent sounds, by drawing the malleus from the incus; by which, therefore, the propagation of the sonorous tremors is interrupted. If the membrane of the tympanum be broke, or the bones of hearing dislocated, the person becomes, at first, hard of hearing, and afterwards perfectly deaf. [This part is the seat of that slight hearing, which is propagated through the bones of the skull.]

§ 483. The malleus returns the tremors impressed upon the membrane of the tympanum, to the incus, which is a short thick little bone,

bone, articulated with the former behind, by a broad surface, with two fulci and a middle eminence. The shorter leg of this bone, whose little body is bifurcated, being suspended by a ligament, is held firm into a sulcus proper to the bone. It descends a considerable length parallel to the malleus, and by a somewhat crooked extremity, is adapted to the fourth orbicular bone, which it receives, convex on one side, flatter on the other, and resting upon the stapes, to which its protuberances are imparted.

§. 484. The *stapes*, aptly enough so called, from its figure, lies inclined, but more backward than forward, with a hollow head that receives the incus, from whence proceed two little crooked legs; but below, its oval basis is occupied by a foramen or aperture of a corresponding figure, commonly called the *fenestra ovalis*. Here the legs, which are sulcated inwardly, are conjoined by a tense membrane affixt to the hollow basis. This bone of the stapes is covered by its own muscle, which being included in a bony papilla or case, sends out a very small tendon, which is inserted under the incus, into the head of the stapes. Hence it seems to draw the stapes, that it may lie higher up, under the back part of the fenestra ovalis, and pass out of it before. Thus the nervous pulp of the vestibulum, is pressed by the basis of the stapes, and by the air of the tympanum. The whole course or seat of the stapes, is separated from the rest of the tympanum, by a membrane proper to itself.

§ 485. There are various channels which pass out from the cavity of the tympanum. The larger of these is that which goes out forward from the interior side, betwixt the multiform and temporal bone, emerges and opens into a corresponding elliptical and diverging cone, partly membranous, and in part made up of cartilages; it opens by a very ample elliptical aperture, turning inward and forward behind the nares, into the cavity of the fauces: this which is called the Eustachian tube, is lined with a porous membrane, full of cryptæ and mucous cells, continued from and like unto the membrane of the nares. This is the tube, which by the action of the circumjacent muscles may be compressed and closed, and probably a little relaxed and opened again, by the circumflex muscle of the moveable palate. By this canal the inspired air enters into the tympanum to be changed or renewed, and the surrounding mucous of the little bones and other parts are this way deposited; nor is it all at improbable, that the air enters by this tube, to support the tympanum, when it is pressed inward by the more violent sounds; for sounds themselves, received into the mouth, are this way conveyed to the organ of hearing. In inspiration, the air presses the membrane of the tympanum outward; and from thence proceeds that clashing or whispering noise, by which the hearing is obscured, when the mouth is held wide open in yawning; for then the air entering more abundantly through the cavity of the tube, to the
tympanum.

tympanum, resists the tremors of the external air.

§ 486. Two other passages lead from the tympanum to the *labyrinth*, or innermost chamber of the ear. And again, the fenestra ovalis, not covered by any membrane, leads into the *vestibulum*, which is a round cavity, formed in a very hard part of the os petrosum, that lies near the inner part of the tympanum. In the same cavity, also, open the five apertures belonging to the *three semicircular canals*. These are formed of a distinct hard shell, very firm and perfect, even in a foetus, which being surrounded with a spongy bone, are lodged in a cavity of the os petrosum; which in adults is extremely hard, extended into large semicircles, which have an ample opening betwixt them. The larger posterior and lower of these circles, is perpendicular; also the middle and upper one is placed towards the perpendicular: but the outermost and least is horizontal. The inner mouth or aperture of the uppermost of these, meets with the upper opening of the posterior ring, and both join into one.

§ 487. But the cochlea is a part still more wonderful, seated in an inclined posture, within the anterior portion of the os petrosum. Into one part of this cavity opens the vestibulum, and into the other the *fenestra rotunda* of the tympanum, which is concealed behind a protuberance in the bottom of the tympanum. The cochlea itself, is made up of a nucleus of bone, of a conical figure, with its apex inclined inward, divided by a middle sulcus, both through

its basis and through its whole length, and perforated with innumerable small foramina into the tubes which are called *scalæ*. About this nucleus are wrapt two turns and a half of a canal, which even in the foetus is made up of a distinct shell-like substance, peculiar to itself; and in the adult is united into one, with the adjacent bone: and this winding canal diminishes gradually in a conical figure, from the two forementioned openings towards the tip of the nucleus, and is bilocular, or made up of two apartments, divided by a partition, called *lamella spiralis*. This, at its larger end, is bony, and extended out of the nucleus, at right angles, into a cavity; is striated and every way wrapt up by the internal periostium, as in a capsule. Another external part hereto belonging, is a membrane which likewise divides the canal: thus there are formed two distinct semicanals, called *scalæ*; the interior and posterior of which begins from the fenestra rotunda, where it is shut by a membrane; and the other begins before, from the vestibulum. In the tip of the cochlea is formed a third funnel-like cavity, which opens into the *scalæ* by a small tube, and communicates with them on each side; but in many bodies it also communicates with the cavity of the bucket, that is filled with the nerve.

§ 488. The blood-vessels of the outer ear come from the proper auricular branches of the temporals; those to the membrane of the tympanum are either from the temporal, from the stylomastoideal, or from both; those of the meatus auditoris come from the former; those

to the tympanum, were described (§ 480.) and the vessels belonging to the vestibulum, cochlea, and semicircular canals, are from the vertebals, and stylo-mastoideals.

§ 489. It now remains, that we describe the nerves destined to the sense of hearing, of which the principal is that called the *seventh* (§ 371.) This nerve enters into the internal auditory sinus of the os petrosum, in the blind end of which it divides, sending off the smaller upward, through the opening of a canal in the sinus; whence passing transversely, it is afterwards bent behind the tympanum; in this part descending, it gives off a branch through a peculiar channel to the tympanum, which ascends betwixt the malleus and incus, and goes out of the tympanum, through a fissure behind the articulation of the lower jaw, afterwards inserting itself into the nerve of the tongue (§ 449.) the reason of which secret communication is obscure, but serves to explain the consent of the teeth, set on an edge by sharp sounds, a removal of their pain by burning the ear, &c. The rest of the nerve escaping by the sides of the styloide process, is distributed through the external ear, the parotid gland, a large part of the face, and upper part of the neck, both cutaneous and muscular; and in the face forms numberless inosculations, both betwixt its own branches, as well as with those of the first, second, third, and fifth pair; and it likewise communicates with the eighth pair, and the third cervical pair. But to the immediate organ of hearing it sends either no branches, or at least very small ones. The

outer ear again receives other nerves in its fore part, from the third branch of the fifth pair, and in its back part to the second and third of the cervicals.

§ 490. But the *soft portion* of the auditory nerves arises larger, but more obscure, from the fourth ventricle of the brain itself (§ 371.) and enters by very minute threads through exceeding small holes of the inner auditory sinus, which go in part to the vestibulum, and in part to the cochlea. The branches in the vestibulum, form a pulp-like tender membrane, which is every way extended through the semi-circular canals. The other part entering the cochlea, has an obscure termination.

§ 491. With respect to the nerve, which is distributed through the vestibulum, and semi-circular canals, there is no doubt but it is struck by the tremors of the external air, propagated to the stapes, from whence the tremors immediately pass through the oval fenestra, to press upon the naked pulp of the nerve. That part of the nerve which enters the cochlea, is altogether obscure in its termination, although it be probable, that small branches from thence pass through the little foramina (§ 487.) to the periostrum of the cochlea, and to the membranous part of the spiral partition. Whether or no the transverse nervous filaments pass out from the nucleus of the cochlea, all the way successively shorter through the spiral plates? and whether, by this mechanism, it becomes the organ of hearing? are curious questions, which we are yet hardly able to resolve from anatomy; though

though this seems repugnant to the course which we observe nature takes in brute animals, in birds, and in fishes, who all hear very exquisitely, without any cochlea. However this may be in the human body, it is there probable, that the spiral plate, spread full of nerves, is agitated with tremors from the oscillations of the membrane of the tympanum, by which the air in the cavity of the tympanum is agitated, so as to press the membrane of the round fenestra, which again agitates the air contained in the cochlea.

§ 492. The preceding conjecture is indeed elegant, since the spiral plates make up a triangle, ending in a short point towards the tip, by which it may be conceived to contain an infinite number of nervous cords, continually shortening in their length; and by that means adapted to an harmonical unison or consonance, (§ 484.) according to the variety of acute and grave sounds, so as to tremble together at the same time with most of them; namely, the longest cords in the basis of the cochlea, with grave sounds, and the shortest cords nearer the tip or apex, with the sharper sounds. [Whether sounds are perceived in the middle semi-circular canals, which yet are said to be absent in the elephant?]

§ 493. From what has been said, it appears, that the elastic waves or tremors of the air, arrive through the outer ear and auditory passage, to the membrane of the tympanum; and from thence the tremors are more accurately conveyed through the small bones, in two ways, to the vestibulum; but in a more confused uncertain

manner through the air of the tympanum, to the round fenestra and cochlea. Of more than this we are not certain: but by undoubted experiments, tremors, and even elastic sounds communicate themselves by the internal Eustachian tube, and through all the bones of the scull, so as to impress their force upon the auditory nerve. The distinction of sounds, as to acuteness and gravity, doubtless proceeds from the celerity of the tremors excited in the hearing nerve, according as they succeed each other more swiftly or slowly, in a short time; in order to which, it is not necessary the mind should number them; 'tis sufficient that she perceive their numbers to be different, and that this difference excites a variation in her thoughts and ideas thence arising. Whether the harmony or agreeableness of sounds arises from the number of parts sounding together in unison? and whether the mind, ignorant of herself, numbers the degrees of consonance, so as to please herself in a majority of them? these are questions denied by the most expert musicians, who make it appear, that there is an agreeableness, and that very considerable, in sounds, approaching the least to a consonance, and which lies in a proportion very difficult to determine. Why sounds often become too sharp for the ear? Our auditory nerves seem to be strained upon the spiral plates, in such degrees as to be in danger of breaking, after the manner drinking glasses may be broke by sharp sounds; and as the hearing is sometimes almost lost for a while, by the violently

violently shrill whistlings of the inhabitants of the Canary islands.

R E M A R K.

This loud whistling that benumbs the ear for a time, is performed by fixing the first joints of the index and middle finger, at above half an inch assunder, upon the lower incisive teeth, which serve to cut the wind thus blown violently thro' a sort of tube, of about half an inch cubical; whose sides are the two fingers, met by the lips above and below. Thus the air, strongly cut by the lower teeth, whistles infinitely louder than when cut by the soft lips only; so that it may be heard two or three miles; and if this tube be over-blown, it will stupify any ear, or even occasion a temporary deafness to some ears, that may have the organs in a certain degree of tension; much as looking at the splendid noon sun, will cause a short blindness in weak eyes.

LECTURE XVIII.

Of the Sight.

§494. **A**S the organ of hearing perceives the tremors of the air, so the sight perceives those of light; and as the first consisted chiefly of bony organs capable of making a resonance: here, on the contrary, the greater part of the eye is composed of pellucid humours, capable of refracting the more subtle medium of light: but the complexity of this organ was necessary for the defence of its tender parts, and from the diversity of the several humours, to be contained each in their proper coverings or integuments.

§ 495. Outwardly, a defence is afforded to this organ by the eye-brow or *supercilium*, which is a protuberance of the skin, sustained by muscles, at the bottom of the forehead, full of thick hairs, marshalled in a regular order, and capable of being pulled down by the action of the frontal, corrugator, and orbicular muscles, so as to afford a shade to the eye in too strong a light. After this office is finished, the eye-brow is raised again, by the insertion of the frontal muscle, thin and fleshy, immediately under the continuous skin, into a tendinous cap fastened to the scull, which cap being of a large quadrangular figure, is drawn backward by the occipital muscle. A depression of the eye-brow serves also to express concern of the mind ;

mind; as an elevation of it denotes the mind to be in a serene quiet state. This guide also conduces to throw off the sweat and retained dust, or the insects which might fall into the eye.

§ 496. The *eye-lids* or *palpebræ*, are placed still nearer guards before the eye. Here the folds of the skin, which are thinly extended, from that of the face, run out in a considerable length, and are reflected back with the cellular substance, interposed betwixt the outer and inner plate, the latter of which becomes then a thin vascular membrane, and therefore of a red colour, extended before the globe of the eye, and spread in its foremost part upon the sclerotica, under the denomination of *conjunctiva tunica*. This production of the skin is every where covered by another of the cuticle, even where it is closely conjoined with the cornea. The upper eye-lid is larger and more moveable; the lower is smaller, and rather obsequious to the motion of the other parts, than moved by any particular forces of its own. The *nerves* which give sensibility to the eye-lids, are numerous, from the first branch of the fifth pair, and likewise from the second; and they abound with *arteries* from the ophthalmics, and from the branches of the temporals, internal maxillaries, infraorbitals, and others of the face.

§ 497. That the eye-lids might shut together more exactly, they have each of them a cartilaginous arch, called *tarsus*, upon their margins, which meet together, which is slender, of a lunar figure, extenuated outward, and serves to hinder the eye-lid from falling into wrinkles,

wrinkles, while it is elevated or depressed. The elevation of the upper eye-lid is performed by a muscle, called, from its office, and arising from the *duramater*, where that departs from the optic nerve and degenerates into the *periostium* of the orbit; from thence the elevator muscle gradually spreading, is extended by its expansion to the *tarsus*. This elevator is considerably assisted in its action, by the *frontalis*, and by various connections with the *orbicularis*, drawn up or dilated by the former. The upper eye-lid is depressed by the *orbicularis* muscle, which is broad and thinly spread round the orbit, under the skin of the eye-lids, to each angle of the eye, which serve as fixed points to this muscle; and it adheres to the *os frontis*, where that bone joins the upper jaw, and then its fibres are inserted into the *os frontis*, and nearest parts of the upper jaw. The same muscle serves to elevate the lower eye-lid, and covers the eye in such a manner that no dust or light can enter it in sleep. The lower eye-lid is depressed by a double portion of fibres, inserted into the upper lip. Finally, that the protuberant margins of the eye-lids might not injuriously beat against each other, the *cilia* or rails of hair are placed spreading outwards, in a row, from the edges of the eye-lids, of different lengths, which by crossing each other make a blind or shade. These are of use in more distinct vision, by excluding the extraneous or more scattered rays, when we require a distinct representation of any object.

§ 498. That the eye-lids rubbing against each other, might not grow together, they are supplied

supplied with a row of *sebaceous glandules*, first noticed by Meibomius; namely, about thirty little gut-like cells, or more in each eye-lid, placed in general, according to the length of the lid, without ever branching, but composed of peculiar blind sinuses, which end at last in one larger serpentine duct, opening by a mouth in the margin of the eye-lid itself. These discharge a soft liniment, which mixes and washes off with the tears.

§ 499. But the perpetual attrition of the eye-lids ascending and descending against the globe of the eye, is prevented by the distilling humour, called *tears*, which preserve also the tenderness of the membranes and of the cornea, and serve to wash out any insects or other sharp corpuscles. These form a saline pellucid liquor, that may be evaporated, and never ceases to be poured over the anterior surface of the eye, but never runs over the cheeks, unless collected together in a larger quantity, from some cause. This liquor is exhaled partly from the arteries of the conjunctiva, as we see from an imitation of nature, by injecting water; and it is in part believed to proceed from a gland seated in a recess of the orbit of the os frontis, somewhat hard, and of the conglomerate kind, intermixed with fat, and painted with many blood vessels from the apthalmics and internal maxillaries; and interspersed with many small nerves arising from a peculiar branch of the first trunk of the fifth pair. From this lacrymal glandule in horned cattle descend three, four or more visible ducts, which open on the inner side of the conjunctiva,

conjunctiva, upon the eye-lid; but in man we are not sufficiently certain of these ducts; and for my own part I have never been able to see any. The separation of the tears is increased by the more frequent contraction of the orbicular muscle, either from irritation, or some sorrowful passion, by which means the tears are urged over the whole surface of the eye, and conjunctiva, which they wash.

§ 500. After the tears have performed their office; some part of them flying off into the air, the rest, that they might not offend by their quantity, are propelled by the orbicular muscle, towards its origination next the nose, to a part which is the lowest of the palpebral margins; which not being surrounded by the tarsus, does therefore not meet exactly together. Here a *caruncle* full of sebaceous hairy follicles, of an oblong figure, interposes and separates the meeting of the eye-lids, at the same time furnishing a liniment to those parts which have none of the Meibomian ducts. Before this part is extended a small portion, like a little eye-lid, which descending perpendicularly, joins the true eye-lids: but at the beginning of this space, betwixt the eye-lids, in which the tears are collected, both in the upper and lower margin, a little papilla stands out, having each of them one opening, surrounded by callous flesh, which are perpetually open, unless when convulsively closed. This opening, which is called the *punctum lachrymale*, drinks up the tears from the sinus, in which they are collected, and this partly by tubular attraction, and partly by impulse,

pulse, from the orbicular muscle. If these points or openings are obstructed, the tears run over and excoriate the cheek.

§ 501. From the said point or opening, proceeds a small duct, both from the upper and the lower eye-lid, much wider than the opening itself, but thin and included in the skin that covers the caruncle; from whence going transversely, they both join together, and are inserted by two mouths near the uppermost part of the *lachrymal sack*: for thus is called a cavity, formed in the os unguis and upper jaw, lined with a membrane, which is at first ligamentary, but afterwards red and pulpy, continued from the membrane of the nares, and is somewhat of an oval figure. From the same sacculus, is continued a duct, which descends a little backward into the nares, opening there by an oblique, oblong aperture, at the bottom of the meatus, covered by the lower os spongosum. Through this passage the superfluous tears descend into the nose, which they in part moisten (§ 465.) [A muscle is by some ascribed to this sack; but it is not yet sufficiently confirmed to enter the list with the others.]

§ 502. The globe of the *eye*, properly so called, compressed before, but longer than it is broad, is seated in the cavity of a bony orbit, which is almost of a conical figure, made up by seven bones, which are in the back part, and on the inner-side perforated, or interrupted by larger fissures, from whence the bones widening forward, defend the cavity on all sides. But as this is larger than the eye itself, the excess

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is on all sides occupied by a very soft fat, surrounding the globe of the eye, that it may both fill and have a free motion within the orbit.

§ 503. The eye begins from a considerable nerve, by the expansion of whose coats or tunics, those of the eye itself are composed. The origin of this optical nerve we have already described (§ 371); and its progress is across under the crus or footstalk of the brain, where it joins with its fellow nerve from the other side, and coheres therewith for a considerable length, by a large portion of medullary substance, but yet without intermixing; so that the right nerve only bends thus to the right eye, and the left to the left eye, as we are assured from experiments. The nerve, therefore, thus enters the orbit a little inflected, of a figure somewhat round, but depressed; and is inserted into the globe of the eye, not in the middle, but a little nearer to the nose.

§ 504. The nerve having reached the eye, deposits the inner plate of its dura mater, which it received in the opening of the sphenoidal bone; and this being expanded and rendered thicker, makes up the first coat of the eye, called *sclerotica*. The other outer plate of the dura mater, receding from the former, makes up the periostium of the orbit: but the pia mater, which is in this nerve very distinct and full of vessels, expands itself as before, so as to form a thin dark-coloured lining to the *sclerotica*. The remaining inner medullary part of the nerve, continued from the brain, but divided into filaments by the cellular substance, appears at first contracted

contracted into a depressed white conical papilla, after which it is again expanded upon the inner membrane of the eye, so as to form the *retina*.

§ 505. The *sclerotica* is in general white, tough, and furnished with few vessels, resembling the nature of the cutis or skin, of a figure completely enough globular, but compressed or flattened before, and of a greater thickness backward; to the fore-part of this globe, cut off circularly, is prefixed obliquely, a portion of a more convex or less sphere, pellucid and made up of many scales or plates, replenished with a clear water and pellucid vessels, very difficult to demonstrate; this part, which is extremely sensible, and almost circular, yet broader at the nose than towards the temples, is termed the cornea, through which the light passes into the eye. This greedily imbibes water, and sweats it out again. Before the anterior and flatter part of the *sclerotica*, and also before the cornea, the conjunctiva is detached from each of the eyelids, and closely conjoined by a proper cellular substance, that may be inflated (§ 496.) which is replenished with vessels, partly red, and partly pellucid continuations of red ones.

§ 506. The origination of the *choroides*, is a white circle, terminating the substance of the optic nerve, in that part where the retina and the central artery are expanded from it, and perforate it by many small foramina. From hence it spreads within the *sclerotica*, concentrically adhering thereto by a cellular substance and many vessels, which enter from the *choroides*

toides into the sclerótica. This membrane is outwardly of a brown colour, but inwardly of a more ruflet brown, or almost black, both which colour and surface are separable by maceration, the innermost being distinguishable by the name of tunica Ruyschiana. When this has extended itself as far as the beginning of the pellucid cornea, it there joins itself more accurately to the sclerótica, by a cellular substance, from whence going off almost circularly in a different course, it forms a kind of rim, called *orbiculus ciliaris*: namely, the coat, which was before spherically expanded, now subtends circularly from the arch of the cornea, a little convex outwardly, and with a deficiency in its middle; from whence a circular parallel portion is taken out, so as to form a foramen of hole, called the *pupil*, which is seated nearer towards the nose, and is larger toward the temple. The anterior part of this round rim, is called the *iris*, and the back part separable from the former, by maceration, is from the colour with which it is painted, called *uvea*. Upon both sides appear numerous stripes, extended like rays of various colours, in different people; but the concentrical orbicular fibres of the pupil are neither visible to the eye, nor by the microscope, not even in an ox, as far as I have been able to observe; only there is one distinct ring of obscure fibres in the body or inner margin of the uveal circle. In the human foetus, and in chicklings of the egg, the pupil is close shut; so that the iris extended, makes up a perfect circular plain. The other part of
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the circle which surrounds the pupil, is vascular. This by degrees contracts itself after the birth, and leaves a free passage for the rays to enter through the pupil.

§ 507. Behind the uvea, from the same circle, by which the choroides and sclerotica join together and outwardly adhere to the cornea, arise thick stripes, extended from the choroides, elegantly wrinkled with parallel vessels, spread under them, which are conjoined by feather-like loose and thin footstalks, into the retina, every way spread with a good deal of black paint, and departing, after the manner of a perforated ring, inward from the tunica choroides, they spread upon the vitreous humour; and lastly, adhere to the capsule of the crystalline lens, and are called by the name of the *ciliary ligaments*. [The origin of the black pigment we are as yet unacquainted with; nor can any glandules be found, which some have assigned for its separation.]

§ 508. But the *retina*, which is truly a continuation of the medulla, from the optic nerve, is next expanded into a sphere concentric, with the choroides extremely tender, and almost of a mucous consistence, dissolvable by a blast; and this immediately embraces the vitreous body. But when the retina has extended itself as far as the ciliary processes, it follows their course, making their stripes and small arteries its foundation or support, in its course to the crystalline lens, to the capsule of which it adheres; and if we may believe the observations of some anatomists, spreads upon its surface. To my enquiry, there

seems to be rather folds or plates than fibres, distinguishable in the retina. [It contains many small blood-vessels, and is covered over by a white nervous substance, which is, by many, counted a proper membrane of the retina.]

§ 509. These coats of the eye, which invest and support each other, after the manner of an onion or other bulbous root, give a spherical figure to the eye, and include its *humours*, by which name are understood commonly three substances, the one a solid, the other a soft body, and the third truly a liquor. First then, the common surface of the retina is, on all sides, filled by the principal or *vitreous* humour, which is contained in a thin pellucid membrane of its own, of a cellular fabric, in the intervals of which is confined a most clear liquor, a little denser than water, which entirely evaporates by heat, like the aqueous humour, from which nature it does not easily degenerate, even in old people. [It has vessels from those of the retina, which appear plainly enough in the eyes of sheep and oxen.]

§ 510. But in the fore-part of the vitreous body, behind the uvea, there is an orbicular depression or sinus considerably deep, into the cavity of which the *crystalline lens* is received, though that be less properly ranked in the class of humours. The figure of this lens is made up of two elliptical convex portions or sides, the foremost of which is flatter, and the posterior more gibbous. The structure of it is that of concentric plates or scales, succeeding each

each other, and composed by the fibres themselves, elegantly figured and contorted. Betwixt the crystalline leaves, is also contained a pellucid liquor, which, in old age, turns to a yellow colour. The innermost scales lie closer together, and form, at last, a sort of continued nucleus, harder than the rest of the lens. [Its arterial vessels are continued through the vitreous body from those of the retina; and the veins return in company with those of the ciliary ligament, § 507.] This whole lens is contained in a strong, thick, elastic capsule of a pellucid membrane, which is lined backward by the uvea, and sustained by the ciliary processes inserted into it (§ 507.) There is also a cellular circle surrounding the lens, formed by the two plates of the vitreous membrane, the foremost of which adheres to the lens by a broad circle, and the innermost is continued behind the lens, together with its capsule; by which means a space is formed, which, by inflation, resembles a ring.

§ 511. Lastly, the *aqueous humour*, which is extremely clear and fluid, and renewed again, if it be let out, is seated in a small space of a curve-lined triangular figure betwixt the uvea and crystalline lens, and in a larger chamber that is before betwixt the iris and the cornea. This humour seems to exhale from the small arteries of the iris, uvea, and ciliary processes, being again absorbed into small veins of the same parts, while some portion of it is drunk up and exhaled through the cornea. This

humour also waters the uvea and capsule of the lens.

§ 512. The eye, thus framed, is outwardly furrounded with muscles, for its government and direction. Namely, into the circle of the sclerotica, which is next to the cornea, are inserted four straight muscles, arising from the dura mater of the optic nerve at the bottom of the orbit, where, departing from the nerve, they cohere with the periosteum, forming, as it were, one circle; from whence, going forward, their bellies lie round the bulb of the eye, and terminate again by their aponeuroses, meeting together in another circle into the sclerotica. Of these, the elevator is the least, and the abductor the longest. The office of these muscles appears very plainly in each of them apart, since, being bent round the convex bulb of the eye, as about a pulley, they must, of course, elevate, depress, or turn the globe of the eye, either to the nose or to the temple. Moreover, two of them, acting together, may turn the eye in a diagonal betwixt the former directions, as upwards and outwards, upwards and inwards, &c. Lastly, when all the four straight muscles, are contracted together, there is no doubt but they draw the whole eye towards its origin within the orbit, by which means the crystalline lens is moved nearer to the retina.

§ 513. But the two *oblique muscles* of the eye are of a more compound fabric; the upper of these, arising together with the recti, is long and slender, ascending forward to a notch
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in the os frontis, which is completed by a double ligament, cartilaginous on each side, and hollow in the middle, almost quadrangular for sustaining the tendon of the muscle. Through this canal passes the tendon of the obliquus superior, which being again reflected backward and downward, included in a capsule of its own, is inserted into the globe of the eye behind the straight muscles. This draws the globe forward and upward, in a manner out of the orbit, that the eye may take in a larger field of vision; it also turns the pupil inward and downward. The other *lesser oblique* muscle, arising from a sinus of the lacrymal foramen in the upper jaw, ascends immediately outwards from the os unguis round the globe of the eye, and is inserted by its tendon into the sclerotica behind the external rectus; whence it appears, on its part, to turn the eye downward and outward, and of course contrary to the former to direct the pupil upward and inward.

§ 514. But there are other more minute muscular motions performed in the eye, which pre-suppose a knowledge of the nerves belonging to this organ. And first, we have already spoke of the optic nerve (§ 503, 504.) The fourth pair goes only to the larger oblique muscle, and the sixth pair belongs to the external rectus. The third and fifth pair produce the principal nerves in the eye; and of these, the first branch of the fifth produces the ophthalmic nerve, and sends off a small nerve from its entrance into the orbit, to the eye-lid and

lachrymal glandule ; it then conjoins with the second branch of the fifth pair, and with the temporal branch of the third and fifth pair. After having entered into the orbit, its trunk divides into two ; of which the upper and larger subdivides into two, which are spent upon the forehead and eye-lids ; but the lower, going inwards above the optic nerve, sends out long slender filaments to the outer part of that nerve, which, joining with another filament of the third pair, makes up the ophthalmic ganglion. Finally, having given off a nerve, running to that of the nose, (§ 458.) it is then spent upon the parts of the internal angle of the eye.

§ 515. But the principal dignity of the *third pair* lies, in giving off a branch upwards to the straight muscles of the eye, and to the eye-lids ; and then, going forward with its trunk under the optic nerve, it sends out three branches together to the lower and less oblique, and to the internal straight muscle ; after this, or often before, (from its trunk, and sometimes from a branch of the lower obliquus) ascends out another short and much thicker nerve, which sometimes joins the root of the fifth (§ 514.) or is sometimes solitary, which, under the abductor muscle, constantly forms the oval *ophthalmic ganglion*. From that ganglion, and sometimes from the trunk of the third or fifth, go out four or five ciliary nerves in a crooked course, playing round the optic nerve in their course to the globe of the eye, where they enter the sclerotica almost in its middle,

middle, in company with its longer small arteries or veins; and running thence straight forward through the choroides, they pass visibly to the iris, and seemingly to the ciliary processes. Upon these nerves, depends manifestly the sensibility of the iris, which contracts itself in all the stronger degrees of light, and dilates itself in all the weaker degrees; and from thence too the pupil is enlarged, in viewing all remote objects, as it is contracted smaller when we look at things very near the eye. The cause of the dilatation seems to be an abatement of the powers resisting the aqueous humour; as we see, for example, in the dilatation that ensues from weakness, fainting, or death. The constriction is, indeed, more obscure, or perhaps arises only from a stronger influx of humours into the colourless vessels of the iris, by which the said vessels are extended together with the iris, which is thereby elongated, so as to shut up the greater part of the pupil. In children, the pupil is more sensible, and more evidently contracted or dilated; but in old people, the parts of the eye, growing callous, it becomes, at last, almost immovable. Other smaller nerves are extended from the same ganglion to the sclerotica.

§ 516. Another more obscure and less easily demonstrable motion in the eye, is that of the ciliary processes (§ 507.), which, lying incumbent upon the furrows of the vitreous membrane, seem, by their action, to press back that body, so as to bring the lens forward, and separate or remove it farther from the retina.

[As for any sphincter of the pupil, or a constrictor of the cornea, mentioned by some writers of note, or even moving fibres, which others have imagined proper to the crystalline lens, they are in no wise supported by anatomy, nor are they consistent with the perpetual hardness of texture, observable in the lens and cornea of most animals.]

§ 517. Moreover, to the history of the eye, belongs a description of the vessels, which, in this part, have a beautiful fabric. But all of those which belong properly to the several parts of the eye itself, come from the *ophthalmic artery*, a branch of the internal carotid (§ 336.). This, creeping along under the optic nerve, sends out, as principal branches, the upper and lower ciliaries, one or more; the lachrymalis, from whence the posterior running to the nose, and internal part of that belonging to the arch of the tarsus; afterwards the muscularis inferior, the anterior recurrent to the nose, the uppermost musculares, and the palpebralis; from whence, with the former branch, springs the arch of the tarsus. Lastly, it goes out forward to the face and adjacent parts of the nose. But the ophthalmic branches, belonging to the inner fabric of the eye, are the posterior and middle ciliaries, which, arising from the trunks before-mentioned, and playing round the optic nerve, in four or more branches, in a serpentine course, go partly in with the optic nerve at its first entrance, and are partly extended further to near the middle of the sclerotica, where they send in twenty or more little arteries to the cho-

choroides, which make first beautiful ramifications upon the external surface of that membrane, round and like the branches of trees; from whence they proceed inwardly in a more direct course, and extend some of their branches as far as the cohesion of the iris, with the cornea and choroides (§ 506.); and here each branch, dividing to the right and left, and intermixing with others of the same kind, at last go to complete the *arterial circle* of the uvea.

§ 518. But to the composition of the same circle, concur many other small arteries; as the anterior *ciliaries*, which, arising from the muscular branches of the ophthalmic, near the origin of the pellucid cornea, perforate the sclerotica by twelve or more branches, and together make up the circle of the pupil. From that circle, and likewise from the fore-mentioned arterial ciliary arteries, independent of the middle circle, are distributed vessels, both on the anterior face, which makes the iris, and on the posterior face of the uvea, together with the ciliary processes; the vessels are distributed, both straight and ramified; the iris is full of a liquor of a bluish colour, otherwise brown; and the uvea is spread with a good deal of a black paint, without which it is naturally white, and sends small pellucid branches even into the chrystalline lens, as I have truly seen.

§ 519. But from the same ophthalmic and its trunk, or from the lachrymal branch, or from one of the ciliaries, one or more branches enter into the optic nerve; the principal of these,

these, being single, penetrates through the medulla of the nerve, and, going out of the middle or apex of the papilla (§ 504.), divides in the center of the retina, from thence spreading its branches every way in company with the retina itself. Sometimes a second or lesser branch goes along the center of the nerve to the retina, and is, in like manner, ramified through it. It is probably from these branches, that the minute pellucid ones of the vitreous tunic are produced. The center of these arteries, entering the retina, is the celebrated *porus opticus*, or blind point of the antients.

§ 520. The *veins* of the eye, in general, being branched like trees in the choroides, conduce but little to the formation of the circle of the uvea. They arise from the ophthalmic vein, which here comes from the vein of the face, and, going out of, or under the bony orbit, is inserted into the cavernous sinus. The internal veins of the eye are fewer in the middle of the sclerotica, which they perforate with larger trunks, and form bushes or trees, somewhat bigger and more anterior than those of the arteries; and another vein perforates the center of the optic nerve, and is spent in the retina like the artery. The pellucid or watry vessels differ not in their course, from those which convey blood. There are also lymphatic vessels said to have been seen by some in the retina, but the observation has not been often enough repeated for us to depend on.

§ 521. So far, with respect to the anatomy of the eye; but that the action of this organ

lies wholly in the reception of light, excepting only a few doubts, appears very plainly from physical and mechanical experiments. *Light* then is a matter either the same, or very nearly approaching to that of fire (§ 2.), extremely fluid and subtle, penetrating through all even the hardest bodies, without receiving alteration from any length or distance in its course, moving with such a very great velocity, as to run through the great orb to us in the space of about sixteen minutes and an half. The light we have in our atmosphere proceeds either from that of the sun, whose body seems to have the power of impelling to us, in right lines, the matter of light, which is confusedly spread around, or else it proceeds from some other ignited point or lucid body; from whence the rays spread every way, as from a center to all points of a large sphere, so as to fall upon the surfaces of bodies; from whence again it is reflected into the eye from the enlightened surfaces in angles, equal to that of their incidence, so as to render the bodies, from whence it thus flows to the eye, both visible and of some colour.

§ 522. It is now sufficiently evidenced from experiments, that light is composed of rays in right lines, almost without any physical breadth or thickness, and yet that each of these rays are again separable into seven other permanent and immutable rays of a lesser kind. The known properties of these rays are, that all of them, conjoined together, constitute a white beam, which, being refracted by the minute surfaces

surfaces of bodies, are subdivided into rays of a red colour, which are more constant or permanent, hard and less refrangible; next to which follow those of an orange, of a yellow, green, blue, and indigo or violet colour; of which those are always weaker and more refrangible, which are farther distant in order from the red rays. A shadow arises from a deficiency in the reflected rays. Those primitive rays, variously compounded together with shade, make up all the variety of colours. The colours then, which seem proper to bodies, arise hence, that the minute surfaces of their constituent solid particles, by which their pores or vacuities are limited, do, according to the difference of their thickness, density, &c. reflect or separate the rays of light, so as to send more of one kind or colour to the eye than another; whilst most part of the remaining rays are lost by repeated reflections within the pores of the substance, so that the strongest and thickest particles reflect a white colour; those next, in density and size, a red colour, 'till at last the minutest surfaces reflect a violet colour. Those bodies are opaque, which retain the rays within their substance, without permitting any to pass through them; which seems to follow from the largeness and the number of the pores, to the sides of which the light is attracted, which pores are filled with some matter that has a power of refraction, different from that which the light suffers from the parts of the body itself. [These principles we embrace till a new theory, that places the diversity of colours,
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like those of sounds, in vibrations of different celerities, shall be better established; although, in reality, we are but little concerned, as to our experiences, in this or any other theory.]

§ 523. These rays, falling obliquely upon the surface of liquors of various densities, pass through them with a change in their direction, by variously receding from, or approaching nearer, to a perpendicular; and this is called their *refraction*. In general, the denser the medium, the more are the rays bent towards the perpendicular, excepting only inflammable liquors, which, by a peculiar property, draw them more to a perpendicular, than in proportion to the density of the liquor. The proportions of the angles of incidence, to those of refraction, are observed to be constant enough, so that the sine of the radius of refraction from air into water is to the sine of the angle of incidence, as 4 to 3; and in the radius, passing from air into glass, the sine of the incidence is to that of refraction, as 17 to 11; and from water into glass, as 51 to 44.

§ 524. Rays, which come through the air with but little divergency, (as do those of the sun on account of their immense distance, or as, in general, do any rays that come from the distance of above 100 feet) falling out of the air upon a denser body, are so refracted, as to meet together in one point, which is called their *focus*; and this point always falls within the axis or radius that is perpendicular to the surface; whence it becomes permanent and unchangeable, so that the focus of rays, passing

sing from air into a sphere of water, will be distant from the axis one semidiameter of the sphere. And in a globular glass, it will be distant a fourth part of the diameter; but, in a convex lens of glass, that is part of a sphere not less than thirty degrees, and equally convex, the focus will be likewise distant one semidiameter, yet so that the rays will meet not in a single point, but in a little circle.

§ 525. Therefore the rays of light, whether direct or inflected, fall, in such a manner, upon the tunica cornea of the eye, as to form a most sharp cone betwixt the lucid point and the membrane upon which they are spread. The basis of which cone will be the surface of the cornea, and the apex in the radiant point, yet so that every ray in this cone may, without any sensible error, be reckoned parallel with each other. Among these, there are some rays reflected back from the cornea, without ever penetrating the surface; namely, all such as fall upon that membrane, in a greater angle than that of forty degrees; and other rays, which enter the cornea, at very large angles, but less than the former, and fall in betwixt the uvea and sides of the crystalline lens, are suffocated or lost in the black paint that lines the uvea (§ 506.), and the ciliary processes (§ 507.); but those rays only fall upon the surface of the lens, which enter the cornea at small angles, not much distant from the perpendicular, or at most not exceeding twenty-eight degrees. By this means, all those rays are excluded, which the refracting power of the

the humours in the eye could not be able to concentrate or bring together upon the retina; without which they would paint the object too large and confusedly.

§ 526. Those slender rays, therefore, coming thus to the thick cornea, which is denser than water, and forms the segment of a sphere, suffer thus a greater power of refraction, and pass through it in a more considerable degree towards the perpendicular, namely, about a fourth part; but these rays, falling with but little convergency upon the aqueous humour, which is small in quantity, and almost like water, making there no focus, because of the nearness of the humour to the cornea, go on nearly parallel, or little converging to the next adjacent surface of the very pellucid or crystalline lens; because their divergency was considerably corrected by the refracting power of the cornea. Moreover, the cornea, being convex, and part of a less sphere than that of the sclerotica, receives and collects a greater number of rays, than if it was flatter, with a less surface.

§ 527. The refracting power of the crystalline lens, which exceeds that of water, may be understood, from its greater hardness, density, or weight, which, by some certain experiments, is computed to be equal with the refracting power of the diamond, so as to make the refracted angle half that of the incidental; or, by other experiments, if the lens be compared with glass, its refraction will be somewhat less; namely, about one and an half. In
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this lens, therefore, and more especially in its posterior very convex side, the rays will converge much together, and pass thence into the vitreous body.

§ 528. This vitreous body is denser than water, in which it sinks to the bottom, but rarer than the crystalline lens, and continues to bend the rays towards the perpendicular, till, at length, in a well-formed eye, the rays, coming from the point of distinct vision, and concentrated into a very small part of the retina, where they paint an image of that object from whence they come; but in a position inverted, from their necessary decussation or crossing of the rays. The manner, in which the images of objects are thus painted, may be seen experimentally in an artificial eye, or by a natural eye, when the back-part of the sclerotica is cut off, and a piece of paper placed to receive the object. But the image we see is painted on the outer side from the optic nerve, within the bounds of the visual axis, yet so that it is not a mere point, but has some degrees of breadth; since we see many objects at once, whose images must be in distinct points of the painted field. And there an object is seen the more distinct, because the rays arrive thither nearly perpendicular. But frequently this point of vision does not fall on the same place in both of the eyes. [When the lens has been couched or displaced, the vitreous body with a weaker refracting power, usually suffices to bring the visual rays together to a focus.]

§ 529. But since the necessary offices of human life require a distinct object to be painted upon the retina, not only by the rays which come from one certain distance, but likewise by rays which come from very different parts, more or less distant; therefore nature has made the lens moveable by the powers before-mentioned (§ 512, 516.) for, without this motion of the lens, we see objects that are either remote, or very near, after a manner, indistinctly. [This art of seeing distinctly, we learn by experience, it being unknown to an eye lately couched of a cataract.] Also, in an artificial eye, the use and necessity of this motion may be plainly perceived. Therefore too great a divergency of the rays, as in those which come from objects very close to the eye, is corrected by a removal of the lens farther from the retina, so as to bring the focus of the diverging rays upon the retina itself, which would otherwise have fallen behind the eye; for the refracting power of the eye being determined, that, which will unite the focus of rays, coming from the distance of three feet, so as to make them fall perfectly upon the retina, will not be able to collect together into the same point, those rays which come from the distance of three inches; and rays still more diverging, will meet together yet farther behind the eye, if they are not collected together by a greater refracting power.

§ 530. But those rays, which come from parts very remote, and which may be, therefore, counted parallel, will meet together be-

fore the retina, in the vitreous body, and again separate according to the nature of rays from the point of concurrence, as if it was a lucid point; to remedy which, therefore, those powers (§ 516.) remove the crystalline lens back from the cornea, nearer to the retina, that the rays, which come together from a certain distance to the lens, may be also united together, at a certain proportionable distance on the retina. For an eye, that will collect the rays, coming from seven inches, so as to unite them on the retina, will collect those together, sooner or before the retina, which come from three feet. It was, therefore, perfectly necessary for the eye to be made thus changeable, that we might be able to see distinctly at various distances. But the point of distinct vision is in that part of the retina, where the given object is painted in the least compass possible. [The powers, causing the visual rays to unite or converge together on the retina, are often very different in the two eyes of one and the same person, so as to render one eye nearly presbyoptical or long-sighted, and the other myoptical or short-sighted.]

§ 531. But this artifice (§ 529.) of the eye is, however, not alone sufficient in all persons. For there are now a greater number of people than formerly employed in a studious or sedentary life, and taken up with the observation of more minute objects, by which the cornea is rendered more convex and dense, and the crystalline lens more solid and of less segments. while the eye itself, by the weight of the humours, is more elongated, and the rest of the humours themselves are probably more densified;

fied; many or all of which circumstances attend the eyes of one person. In such, the iris is sensible in a small light, whence, by winking or straining the eye-lids, they are denominated *myopes*, short or near-sighted; in these, the point of distinct vision is very near to the eye, from one to seven inches from before the cornea; but they see remoter objects more obscurely, without being able to distinguish their parts. The reason of this is evident, since, from the forementioned causes, there is a greater refracting power of the humours, by which the distant, and consequently parallel rays, are obliged to meet in their focus before the retina; from whence, spreading again, they fall upon the retina in many points. Thus also to a good eye, the sense of objects, which are too near the cornea, is confused, because the rays, coming from thence, are spread all over the retina, without being collected towards the center.

§ 532. The remedy for this fault in the sight is to correct it in its birth or beginning, by viewing distant places, by keeping the eyes from minute or near objects, and by the use of concave glasses, or by viewing things through a small hole, by which the light is weakened. When the disorder is confirmed, the remedy is a concave lens, which takes off a degree of the refracting power in the humours, cornea, and crystalline lens, in proportion, as it is more concave, by which means the focus of rays, from remote objects, is removed farther behind the cornea, so as to fall upon the retina. This

glass ought to be a portion of a sphere, whose diameter is equal to the distance of distinct vision from the naked eye, squared by the distance of distinct vision in the armed eye, and divided by the excess betwixt them. [Age itself advancing, gives some relief to the short-sighted ; for children are, in a manner, naturally myoptical : but, as the eye grows older, it becomes flatter, in proportion as the solids grow stronger, and contracting to a shorter axis, the converging powers of the lens and cornea are diminished.]

§ 533. Another disorder of the sight, contrary to the former, troubles people, who are often looking upon very distant objects, and is more especially familiar and incurable in old people ; whence the person, thus disordered, is called *presbyopus*. In such a one, the cornea and crystalline lens are flatter, and the humours of the eye have a less refracting power. Hence near objects, whose rays fall very diverging upon the cornea, appear confusedly, because the converging or refracting powers of the eye are not sufficient to bring the rays together in a focus upon the retina, but the rays go on scattered through the retina, and throw the point of their pencil behind the eye ; from whence vision is confused. The point of distinct vision, among presbyopi, or old or long-sighted people, is from the distance of fifteen to thirty inches.

§ 534. Such persons are, in some measure, relieved by looking through a black tube held before the eye, by the use of which the retina grows

grows tenderer, and the rays come in a more parallel direction. The remedy here is a convex lens of glass, which may cause the rays to converge and unite together sooner in a focus, that it may fall not behind the eye, but upon the retina. The diameter of the sphere; of which such a lens ought to be a portion, is determined as before (§ 532.)

§ 535. The medium betwixt short and long-sighted is the best, by which a person can see distinctly enough objects, that are both near and remote; and of this kind we reckon an eye, that is able to read distinctly at the distance of one foot. But to this are to be added other necessary conditions, such as a perfect clearness of the humours, a due mobility of the eye itself, and its parts, a sensibility of the pupil and retina; neither too tender nor too tough.

§ 536. But the mind not only receives a representation of the image of the object by the eye, impressed on the retina, and transferred to the common sensory or seat of the soul; but she learns or adds many things from mere experience, which the eye itself does not really see, and other things the mind considers or interprets to be different, from what they appear to her by the eye. And first, the *magnitude* of an object is judged of by an optical angle intercepted, as the basis of a triangle betwixt the cornea, and as the point of a cone betwixt the radiant object. From hence, things very near seem large, and remote objects seem small. Hitherto may be referred the power of microscopes,

scopes, by which objects are made to appear to us so much larger, as the distance of the focus of the lens or magnifier is less than the distance of distinct vision; when, in reality, they do not appear larger, only more distinct and lucid; whence the mind judges them to be larger or nearer.

§ 537. The strength of visual light likewise is proportionable to the same angle, in the external day-light; and the multitude or number of the rays, joined with the smallness of the seat, which they affect in the retina, occasions near objects to appear brighter, and distant objects more obscure; or if a remote object appears bright by its own light, the mind represents it either as one large, near at hand, or both.

§ 538. The *place* of a distant object appearing to the eye, is estimated by the concurrence of two lines, drawn from the center of the seeing eye, till they meet together, or join in the space that lies betwixt the point in which the object appears visible in the right eye, to the same point in the left eye; which lines, if they no where intersect each other, will represent the object double, or, if they meet upon each other, we place the seat of the object in the point of intersection. But *distance* we are not able to see, only we judge of it from the diminution of magnitude before known, as well as from the angle intercepted betwixt the two optical axes, together with the weakness of the light, and paleness or faintness of the image, coming from the object in conjunction with the number of intermediate

diate bodies, whose distances were before known to us. But we find all things are fallacious, that are not founded in the infallible wisdom of the Creator, but arise by experiences in the judgments of mankind.

§ 539. Thus the convexity or *protuberance* of a body is not seen; but is afterwards judged of by experience, after we have learned, that a body, which is convex to the feeling, causes a certain mode or habit in light and shadow. Hence it is, that microscopes frequently pervert the judgment, by transposing or changing the shadows.

§ 540. The visible *situation* of the parts of an object, are judged by the mind to be the same with that which they naturally have in the object, and not the inverted position, in which they are painted upon the retina. But it is certainly a faculty innate or born with the eye, to represent objects upright to the mind, whenever they are painted inverted upon the retina: for new-born animals always see things upright, and are never mistaken in enquiring for their mother. And men, who have been born with cataracts, without ever being able to see, are observed, upon couching the cataracts, to see every thing in its natural situation, without the use of any feeling or previous experiences.

§ 541. One thing, which imposes upon the mind, is, the continuance which external sensations make, during almost the space of the second of a minute, after they have been conveyed to the sensorium by the eyes; whence

they are represented to the mind, as objects really present. From hence proceeds the idea of a fiery circle from the circumrotation of a lucid body; and from hence proceeds the continuance of the shining image of the sun, and sometimes of other bodies, after they have been viewed by the eye.

§ 542. If it be questioned by some, whether it be true, that the object is painted upon the retina? or whether this painted image be not made upon the choroides? or whether this new opinion be not confirmed by the experiment, that shows the part of the eye to be blind or insensible, where the optic nerve enters into it? and whether this be not explainable, because no choroides being there, the naked retina is incapable of seeing? we answer, that this late supposition is inconsistent with known observation, by which the retina is evidently a most sensible expansion of the nerve, while the choroides has only a few nerves, with small vessels, which are certainly blind. It is also opposed by the great variety of the choroides in different animals, while the constant uniformity of the retina is equally as remarkable; to which add the black membrane, that is interposed betwixt the retina and choroides, in some kinds of fish. Finally, anatomy demonstrates, that the choroides is seated in the blind part of the eye, but of a white colour. Moreover, from this experiment, we have a reason, why the optic nerve is inserted on one side, and not in the optical axis of the eye. For thus, excepting one instance, when there
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is any object in the intersection of lines drawn through the center of the optic nerves, it is always seen by one eye, that it may be able to assist the other, whose blind part is turned towards the object.

§ 543. Whether we can see but one object distinctly at a time, and that placed directly before the retina of the eye that sees distinctly? and whether the mind persuades herself she sees many objects, partly from the continuance of the ideas they excite, and partly from the celerity of the motion in the eye? we answer in the affirmative, with respect to distinct vision; but it would be too much to assert this, with respect to indistinct vision. If it be demanded, from whence proceeds the blindness that happens to some in the day-time, and to others in the night? we answer, that the nocturnal blindness is familiar to many countries in the hottest climates, and to old people, who live under a very hot sun; but the diurnal blindness is familiar to those who have inflamed eyes, and to young persons of an inflamed habit, whose eyes are, therefore, extremely tender. Thus the one is produced from too great a tenderness of the retina, as the other proceeds from an hardness or insensibility of it. Whence proceeds the nocturnal sight of animals? from a large dilatable pupil, from a tender retina, and from a shining choroides, strongly reflecting the light. Whence is it, that we are blinded by passing from a light into a dark place? because the optic nerve, having suffered the action of stronger causes, is, for the present,

sent, less affected or moved by weaker causes. Whence have we a pain, by passing suddenly from a dark place into the light? because the pupil, being widely dilated in the dark, suddenly admits too great a quantity of light before it can contract; whence the tender retina, which is easily affected by a small light, feels, for a time, an impression too sharp or strong. Whether see we with one eye or with both? frequently with one, and more especially the right eye; but when both are employed together, we see more objects, and more plainly; and we also distinguish more points of the same object, and judge better of their distances.

LECTURE XIX.

Of the internal Senses.

§ 544. **H**ITHERTO we have considered the senses as they are, each of them apart. It is now common to them all, that the tender pulp of the nerve, being struck or impressed by external objects, conveys a change by the nervous spirits, to that part of the brain where the impressed fibres of the nerve first arise from the arteries (§ 383.). We know nothing more, than that new thoughts are thus excited in the mind; which we call *perceptions*, with respect to the thinking mind herself, and *ideas* with respect to the objects from whence they arise. Perception is therefore excited whenever any of the forementioned changes in some of the sensible organs, are transferred to their first origin; for the thought or sense by which the perceiving nerve itself is affected, is no express image or idea of the object. The idea of redness has nothing in common with rays but little refrangible, and separated from the seven portions of which rays of light are composed; and much less is it consistent with optical principles for the image painted by rays, upon a soft white nerve, to be conveyed through a most opaque body, in a long course of perfect darkness, to the origin within the thalami. There is nothing in the pain of burning that can represent to the mind its swift and subtle matter,

matter violently moved, by the particles of which the continuity of the nervous threads is broke or destroyed. There is nothing in the idea of a sharp sound, from a chord of a certain length, that can inform the mind the said chord trembles 2000 times in the space of a second. But it is established as a perpetual law, by the Creator, that certain changes, made first in the nerve, and then in the common sensory, shall produce certain new corresponding thoughts in the mind, which have an indissoluble connection with each other; so that, although what we perceive in the world be arbitrary, yet that it is real and not false, appears plainly from the perpetual agreement of similar thoughts arising from similar affections of the sensitive nerves, in all persons at the same time, from one object, or in one person at different times.

§ 545. It appears from certain experiments, that the first origin of every perceiving nerve, is always distinct; and that the change which is first excited by the external object in the said nerve (§ 544.) continues in the origin of that nerve for a considerable time; and also that those changes are so classed and laid up within the said part of the brain, that those are nearest together, which were either contemporary or nearly so, or which have succeeded next in course; or lastly, which have a relation to the same subject, or were excited by similar objects: insomuch, that it is certain, new species or ideas are always conveyed again to the same part of the brain, where others of the like kind are reserved; for otherwise the arbitrary signs
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of words and letters would never be able to renew the same old ideas again in the memory ; nor could disagreeable ideas, returning into the mind, without the assistance of external objects, re-produce the same effects, as would the disagreeable objects themselves ; nor otherwise, could there be so constant and manifest a connexion of analogous ideas, which most powerfully occur in dreams, according to the corporeal causes which then remarkably act in the brain. Whether or no imagination and memory do not depend on this conservation of ideas ? Finally, those changes in the sensorium, which many term past or reserved ideas, are for distinction's sake by us called the *species* of things, which are lodged or engraved not in the mind, but in the body itself, by certain notes or characters, incredible in their minuteness, and infinite in their number, recorded after an inexpressible manner, in the medulla of the brain. Amongst these characters, such are more eminently and distinctly preserved, as were received, first by the sight, and next by the hearing ; for those of the other organs are more confused and irrevocable.

§ 546. *Imagination*, then, is whenever any species, preserved in the common sensory, and in present perception, excites such other thoughts in the mind as would arise if the perceiving nerve that gave the first birth to the said species, was itself affected or changed. This definition is confirmed by examples of the great strength of fancy in certain persons, and those who are delirious ; but in every body, in the instance of
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dreams, in which thoughts arise in the mind, occasioned by the corporeal species reserved in the brain, so as to be not at all weaker than those which were first formed by the change in the sentient nerve, from the external objects. Even more, the attention and rest of the mind, with the absence of all external objects, will often obtain a stronger assent from dreaming, towards the said species impressed in the brain, than that which is given from the mind by the perceptions which are excited from external objects: for the will is more powerfully determined in those who dream, than in those who are awake, so as often to perform certain actions by the voluntary muscles, while they are asleep, which they never can perform awake, even though the same nerves were more strongly affected by the real objects. From hence we may understand, how it is possible the internal species, which are very strong in a delirium, may so impose upon the mind, as to make her mistake them for the perceptions of external objects; as for example, in the fiery sparks, which are excited by pressing the eye, and optic nerve; in the redness seen by the eye when it is shut; in the vertigo or rotation that arises from a motion of the retina, which we ascribe to the external objects themselves; in the duplicity of sight, &c.

§ 447. But *memory* is, when any internal former thought of the mind, or the species perceived and preserved in the brain, from external objects (§ 383.) repeat or excite again other perceptions in the mind. And here the perceptions are commonly weaker than in the imagination,

gination, being almost only certain arbitrary signs conjoined together, with the idea that was first perceived in the mind; for the memory hardly represents the images and pictures of things to the mind, only the words or signs,* and certain attributes, together with the general heads of ideas; for which reason they move the will with less force; but it appears from the observation of those changes, which happen in the memory, that such as arise from the external senses, remain longest in the brain; and sometimes, if they made a strong impression, they may for ever, and in all ages of life, be repeated to the mind; but they are weakened, and in a manner blotted out in time, by degrees, unless the representation be renewed again to the mind, either from an external object, or from the mind itself, recalling the same change again into memory; so that without this repetition at last, the change or impression will be in a manner erased and quite lost; and together at the same time, will never be able to be drawn in again to the mind, whenever she repeats such other thoughts as had naturally any connection with the former. This destruction of new and different species, conveyed to the sensorium, is evident, not only from the effect of time, but likewise from cataleptic disorders. But sometimes all of them will be suddenly destroyed by disease, in which the brain is any how compressed, either from the blood or other causes. Such a compressing cause, acting on some part of the common sensory, blots out a correspond-

* For a man cannot think without words unexpressed, any more than he can speak without thoughts,

ing number of the species from the mind or memory, whether they be certain or all kinds of words, or even the characters by which we express words; or lastly, the characters of our friends and necessities of life; yet all these species are often again renewable to the mind, whenever the compressing causes remove from the sensory. But the strength and duration of an idea depends upon its being either unusual, of a strong action, or greatly conducing either to increase or lessen our felicity; or lastly, from being joined with great attention from the mind, and often repeated; all which circumstances being conjoined, may render the species so strong to the mind, that she will afterwards receive the perception of them, as if they came from external objects, in the manner we observe in mad people.

§ 548. Moreover, if we review the history of human life, it will appear, that in the beginning of our infancy, we have hardly any memory, only simple perceptions, that soon vanish: which nevertheless do for the present excite strong thoughts or impressions in the mind, as we learn from the clamours of infants. But afterwards, the memory is perfected by degrees, and the ideas received from persons most beloved and familiar to the infant, remain impressed in the mind; while, at the same time, the imagination likewise increases in proportion, so as to be often very powerful in young children, as we see for example, in fears or frights, which in no age produce more violent or fatal effects. From thence forward, as the number of
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of our ideas increases, the faculty of preserving those past weakens; and at the same time the power of the imagination is more torpid or sluggish, till at last the former almost perishes, and the ideas, which are received but a short time, escape from the brain, while at the same time the imagination, which is a kind of memory, languishes in proportion.

§ 549. But since the perceptions thus formed in the mind, produce in her various changes, which are perfectly free, and distinct from any corporeal faculty, we shall briefly add something concerning them, so far as may suffice to the purposes of physic. *Attention*, then, is said to operate when the mind observes one and the same idea alone, and for a longer time together. The comparison of two, or more ideas, brought to the mind, is called reason; as the similitude, diversity, or relation perceived by the comparison, is called *judgment*. The principal cause of wisdom and invention, lies in a slow examination of the ideas, considered in the relation of all their parts one to another in the mind, while neglecting all other objects, she is employed with a strong attention only, upon that which is under examination. From hence proceeds that efficacy of solitude and darkness in making difficult calculation, with the more exquisite attention of blind people to the nature of sounds, and of those who are deaf, to colours. The source of error is some neglect in contemplating the whole idea, or the making an estimate of it from only a part of its note or character, or from a less congruous connection of some ideas

with others that are distinct; but only related by accident, external causes or affections.

§ 550. The integrity or soundness of the judgment, depends upon a perfect and healthy constitution of the brain. For the fabrick of the encephalon being changed, either by compression, irritation, or a deficiency of blood, confounds all the use of reason, occasions the strong internal species of the brain to be represented to the mind as if they came from external or real objects, breaks the connection of the ideas, so that the mind cannot compare them together, and is consequently unable to judge of, or foresee their proportions, differences, or consequences, starting immediately from one idea to another, that has no kind of relation; or lastly, the actions of the senses being either weakened or abolished, and the brain in a manner deprived of its corporeal species, the man is reduced to the state of an idiot, an oyster, or a plant. But the powers of external bodies also have a considerable influence in changing the species of objects, which the mind acquires by the senses; for the air, way of life, food, and customs, either help or diminish the soundness of the judgment, the force of the imagination, and the strength of the memory.

§ 551. Finally, as these ideas are either indifferent to us, or else conduce to the loss or increase of our felicity, so they produce different determinations in the *will*. Some of these ideas, by which the felicity of our mind is either increased or diminished, arise merely from the mechanism of the perfect body; and amongst these

these corporal pain, is a sorrowful sense or perception in the mind, to which every violence or over-strong sensation in any nerve, seems to serve as a foundation; while pleasures consist only in the more moderate impressions or tensions of the nerves. Itching stands related as a medium, either to pleasure or to pain; but to pleasure it is related, inasmuch as both have an increased flux of blood and spirits into the parts in which either the pleasure or the titillation is perceived; but in pain, these are increased to a great degree of tension, or to an over violent sense of the nerve. Anguish or anxiety is from an over distension of the vessels, because the blood is hindered from passing freely through the lungs. The other ideas with which the mind is affected, are either wholly abstracted from the properties of matter or body, or are at least much less simple than the foregoing, which arise either from sense or mechanism. The perception of good ideas, excites joy; the desire of possessing good, excites love, as the expectation of it is the cause of hope: on the contrary, present evil causes sorrowfulness, terror, or despair; the desire of shunning evil excites hatred and the expectation of a future evil; excites fear.

§ 552. From these affections of the mind, the mere will appears not only to be determined to some foreseen purpose, to which it directs the actions of the body, in order to possess good and avoid evil: but also in the body itself, unconsulted, and making no great resistance, it exercises an equal dominion over the

pulse, respiration, appetite, strength, affections of the heart, nerves, and stomach; with the changes which arise in the other parts, serving as signs of the passions in the mind, from which they immediately follow. Thus anger excites a violent motion of the spirits, causes a palpitation in the heart, a frequency of the pulse, a greater strength of the muscles, urges the blood into the smaller pellucid and improper vessels; and, lastly, hastens the expulsion of the bile from its vessels, by which means it frequently removes obstructions, or eases chronical diseases. Grief, on the contrary, weakens the strength of the nerves, and the action of the heart, retards the motion of the pulse, destroys the appetite and digestion, whence it produces a paleness, cachexy, diarrheas, jaundice, scirrhusities of the glands, and other slow diseases, arising from a stagnation of the humours. Thus also, fear so much weakens the strength of the heart, as to occasion polypuses, paleness and weakness of the whole, a palsy or relaxation of the sphincters, an increase of the inhalation of vapours, but a diminution of those discharged by perspiration. Terror from a present evil, will also increase the strength to so great a degree, as to cause convulsions and a strong pulse, whence it sometimes removes obstructions in palsies, or by intercepting the course of the blood, it kills suddenly. Love, hope, and joy promote the perspiration, quicken the pulse, and give the blood a free circulation; whence they increase the appetite, and render diseases curable. But excessive and sudden joy often kills by increasing the motion

motion of the blood, and exciting a true apoplexy. Shame, after a peculiar manner, retains the blood in the face, as if the veins were tied; it will also suppress the menses or other secretions, and has been even known to kill.

§ 553. But in what manner are these changes (§ 552.) produced, from the commotion of those passions in the mind? Do not the nerves cover the vessels like sphincter muscles, so as by contracting them suddenly, they increase the course of the blood, or by relaxing and weakening their tone, retard and vitiate the circulating juices? That this is the case in the smaller vessels, appears evidently from the near similitude of effects in fear and cold, upon the nerves of the skin. But in the genital parts, from a constriction of the veins, under particular circumstances, we perceive that the blood is manifestly collected or accumulated in the parts; and it is no less probable, that even in the larger vessels, the nervous bridles with which many of them are surrounded, produce the same effects; for thus in several parts, they surround and include the meningeal, temporal, vertebral, carotid, subclavian, cœliac, mesenteric, renal, and other arteries. As a person's nerves are more or less tender or sensible, so the arteries are in proportion more or less irritable; and so act with a greater or less force, on the same quantity of blood, which accordingly moves swift or languid. And thus it is the appetite and peristaltic motions of the alimentary tube are manifestly destroyed or depraved by the passions of the mind, (§ 44.)

§ 554. Nor is it to be denied, that the creator has affixed certain characteristic marks or evident signs to the passions of the mind, that in mutual society, one man might not impose upon another. For the respective muscles, more especially of the voice, face, and eyes, do naturally express the several passions of the mind, so faithfully, that they may be even represented by a painter. To run through them all, would indeed be an elegant theme, but too long for this Compendium. [From the actions of these muscles, oftener repeated by the affections, follows the features or physiognomy of a person's face, which, if not dissembled, is a perpetual index to the state of the mind.]

§ 555. From whence proceeds the consent of parts, which is so famous and often repeated by writers on the practice of physic? (1.) Some of them appear to depend upon the conjunction or inosculation of the blood-vessels, by which the blood being drove out of one, is more strongly urged into another vessel, which has its branches from the same common trunk. Hitherto belong the revulsions made by blood-letting, the pains of the head, which ensue from a cold in the feet, &c. (2.) In other parts, the consent arises from a similitude in their fabrick, by which they suffer like effects, from the same causes in the body; hitherto we refer the consent that is betwixt the womb and the breasts. (3.) Another cause of this consent is, a continuity of the membranes, extended from one part to another; from hence a stone in the bladder excites an itching in the
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glans of the penis, a diarrhea cures a deafness arising from a defluction. (4.) Another cause of consent lies in the nerves themselves, and their anastimoses or communications one with another, as appears plainly from the teeth being stupified or set on an edge, by certain sounds, because the various communications which the hard portion of the auditory makes with the maxillary nerve, transfer the disagreeable sense of the latter. Thus also, the sympathy of the eyes, which is not observable in like manner in the ears, proceeds from the mutual conjunction of the optic nerves within the skull; and thus in diseases, a stone in the kidney excites vomiting in the stomach, &c. (5.) Lastly, the consent may proceed from some cause acting on the common sensory, and beginning of the nerves, whence the irritation of a single nerve manifestly excites ample convulsions, spreading through the other parts; so an universal epilepsy will proceed from a local disorder, &c. [A consent is observed in some diseases from a translation of the matter of a disease by filtration, through the cellular substance of one part to another; and another kind proceeds from the incumbent weight or actions of the adjacent muscles and arteries.]

§ 556. But there is still another remarkable consent to be explained betwixt the body and the mind. For that the nature of the mind is different from that of the body, appears from numberless observations, more especially from those abstract ideas and affections of the mind, which have no correspondence with the organs

of sense? for what is the colour of pride? or what the magnitude of envy? For is it possible, that a body can acquire two kinds of forces, by the uniting of an infinite number of smaller parts into one mass, each of which shall not only preserve their own particular properties and affections, and represent themselves, but also join together into one conscious whole, differing from all the characteristics of its component parts, and yet be capable both of perceiving and comparing the attributes of those parts? Is there any one instance of a body, which without an external cause, can, like the mind, pass of itself from rest to motion; or is there any body that can change the direction of its motion, without the action of some other cause? Let those consider who have well observed the voluntary actions of the human body from the mind.

§ 557. Yet the mind, however different from the nature of the body, is closely tied to the same, under certain conditions; so that she is obliged to think upon those species which the body offers to her perception; and again, so that she cannot perceive, remember, nor judge without the use or representation of those corporeal species, which are lodged in the brain; and again, by her will is the cause of the greatest and swiftest motions in the body.

§ 558. Those have behaved modestly, who confessing themselves ignorant, as to the manner in which the body and mind are united, have contented themselves with proceeding no farther than the known laws, which the Crea-

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tor himself has prescribed, without inventing and supplying us with conjectures, not supported by experience. We may be manifestly excused in this respect, from the observation, (§ 544.) which is here equally certain, as in optics, that the affections of bodies cohere with the thoughts of the mind, by an arbitrary relation or connection, in such a manner, that they would produce other thoughts of a different kind, if the Creator was to alter the figure of the refracting power, or colours of the parts of the eye. Thus he has established a law, which obtains always, betwixt the least refrangible rays, and the connexion of a red colour or idea in the mind ; thus there is a law betwixt the impression of those rays upon the retina, and the connexion which he has appointed of the corresponding thought. Nor need we be more ashamed to confess our ignorance in the mechanism of this ultimate law, in the effects of nature, than we are to own ourselves unacquainted with the first causes of our being and operation.

§ 559. But it will, perhaps, be demanded of us, whether the mind does not govern the whole body ? and whether or no all the motions and actions in the body do not arise from the mind, as the immediate spring and principle of motion ? whether or no even the motion of the heart, arteries, and respiration, do not arise from the mind, conscious and solicitous for the common good of the whole system ? whether or no this power of the mind, does not appear in the stopping of hemorrhages, from wounds, by grumous concretions ; to which
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add, the force of passions of the mind, and the power of the mother's imagination, in the marking or other blemishes of infants? whether or no the absence or want of consciousness in the mind, with respect to these defects, be not excuseable from the known obscurity of attention which she gives to the respiration, the motion of the eye-lids, and muscles of the eye itself, the ear or tongue; all which motions, we know, are effected by the will, although we know not the organs, nor take any notice of the action of the will, when we breathe, look, hear, or even walk, while we are taken up with other thoughts? whether or no it is certain, that all bodily motions arise from the mind, on the account of our being unable to find out any other cause, constantly united to the body, to which we can manifestly refer them?

§.560. There are indeed many reasons which will not permit us to consent to this opinion, which has of late years been publicly professed by Dr. Sthall, and his adherents through Germany; and in England, by Dr. Nichols. And first, the construction and government of the body itself, appear greatly to exceed all the power and wisdom of the mind. The *anima*, or mind, is able to see but one point distinctly at a time (§ 543.) and it can think only one thought or idea at once; for if it endeavours to see two objects at a time, or to contemplate two different ideas together, the sense of both is immediately confused, the mind strays in her reasoning, and makes no right judgment of either object; insomuch, that being sensible of
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this her weakness, whenever she endeavours to make a serious and diligent enquiry into any object or intended work, she withdraws herself, and shuts up all the ports of sense, without taking any impressions either by the sight, hearing, smelling, &c. or without exercising any of the voluntary motions of the muscles. But the mind ought to be capable, not only of infinite thoughts, but also distinct ones, for her to be able to perform and govern so many hundred muscles, organs, vessels, and moving fibres, in such a variety of ways, and with so great an exactness, as is difficult to, or even above all the solutions that can be given by the working of geometrical problems: and yet, by this hypothesis, the mind, ignorant both of herself and of her works, ought not only to be equal to so immense a task; but likewise, at the same time, she must over and above those works, be capable of contemplating the most difficult and abstracted ideas, without either disturbing her meditations by the cares which concern the body, and without neglecting any of her necessary corporeal offices, by the variety of her mental operations.

§ 561. Moreover, if, without being conscious of our will, we are nevertheless able by that faculty, to influence the respiration, the winking of the eyes, &c. and even to be able not only to govern, but also to suspend our breathing, shut or close our eyes, and open them again; it follows from thence, that we never lose either the consciousness, or the use of those actions, and consequently neither the government of them.

them. But we are able to perform nothing of this kind in the heart or intestines; we cannot refrain the motion of those parts when they are too quick, nor excite them when they are too languid. In such a number of persons as inhabit the world, why do we not meet with some who can govern the motion of their guts? or why in all the ages of the world, not one who could govern the contractions of the heart? If custom only is the cause of this unknown power, why does not the mind receive a sense of her action, in moving the heart, after it has stood still for whole hours, or even days, in swoons, in hystERIC fits, and in persons drown'd?

§ 562. But it is evidently a false position, that all the motions of the body arise from the mind, without which the body would be an immoveable unactive mass; for the force of muscular contraction, by any kind of stimulus, to which the motion of the heart, intestines, and perhaps all the other motions in the human body are obedient (§. 400.) do not require the presence of the mind, since that power continues a considerable time in a dead body, and may be recalled again into action, by mechanical causes, as heat, inflation, &c. nor does this power desert the fibres, so long as they continue unstiffened by cold, although the mind may have been a long time separated from the body, by a destruction of the brain; and this action we see more evidently in the heart, after that muscle has been taken out of the body for some time, so as to be separated from any imaginable connection with the mind.

§ 563.

§ 563. As to the blemishes of infants, we have declared in another place, how little that article is to be depended on*. The administration of the vital motions, in diseases, is not under the rule of any prudence, but governed almost merely by the power of stimulus, as we are manifestly taught from the most antient and only certain practice, by which we are directed to restrain the too great violence of these motions in acute and intermitting febrile diseases, by the use of blood-letting, with the poppy, nitre, peruvian bark, &c. The wisest philosopher in the world has no more privilege or advantage in the government of his body, than the merest ideot; and that even infants should build up the fabrick of their own body, before they know that they have any muscular motions, is an assertion so far from being credible, or even moderately probable, that of itself alone it is sufficient to refute the hypothesis.

• See Lecture following.

LECTURE XX.

Of Sleep.

§ 564. **A** Ready disposition to the exercise of sense and voluntary motion, in healthy organs; is called vigilance or wakefulness; but an indisposition to such an exercise of them, with an inclination to rest, in all the said organs, while they remain healthy and entire, is called sleep.

§. 565. In sleep, the mind either thinks not at all of what she knows or retains in memory; or else she only attends to the corporeal species of past objects repositied in the common sensory (§ 544.) the vivid representations of which excite altogether the same perceptions as are made by the impression of external objects; upon the organs of sense, by which they were first received. These representations of species to the mind, are called dreams, and happen whenever a small portion of the brain or common sensory, is by the refluent motion of the spirits, kept in a state of vigilance, while all the rest of the empire of sense and voluntary motion, is silent and at rest. Sometimes there are certain voluntary motions, following of course from the perceptions thus perceived by the mind, such as speech or motion, of all or some of the limbs, conformable to the nature of what the mind perceives; and hitherto are to be referred those who walk in their sleep. § 566.

§ 566. But during the time of sleep, the motion of the heart, with the distribution and circulation of all the other humours in the body, are regularly continued, together with the peristaltic one of the stomach and intestines; and finally, the action of the sphincter muscles, with the respiration, are continued in a like manner. This composition, in which a certain number of the organs are at rest, while others continue their motions, renders a knowledge of the mechanical cause of sleep somewhat difficult to attain.

§ 567. Therefore, in order to make this discovery, with all its causes, we shall consider all the appearances both of sleep and vigilance, and trace them in all kinds of animals; for that condition which appears constantly to follow from all those causes and appearances, will be the true and mechanical cause of sleep.

§ 568. Sleep naturally follows after the vigilance and labour, which are joined to human life, have been for some time exercised. For when a person is awake, there is a continual motion or exercise of the voluntary muscles, of the parts which guard the senses, and of the affections of the mind, all which continually add a new stimulus to the nerves, blood-vessels, and heart itself. Thus the blood, by continual motion and triture, changes its smooth albuminous nature, to a rough alkaline, and in some degree putrid sharpness, while at the same time its more fluid parts, especially those subtle ones which compose the nervous spirits, are consumed and dissipated faster than they are secreted

or made, whence gradually ensues both a weakness and a weariness of the body ; and if the vigilance be continued longer than usual, there is also a feverish heat, a greater acrimony of the humours, and a sensible loss of the strength. As the night advances, a weight or heaviness seizes all the large muscles and their tendons, the mind becomes unfit for any accurate thought or study, and seeks after rest. Hereupon the powers which hold the body erect, shrink from their office, the eye-lids close, the lower jaw falls down, a necessity of yawning or gaping attends, the head nods forward, and by degrees we take less notice of the external objects, which also affect us less, till at length all the thoughts and ideas are in confusion, and a sort of delirium ensues, from whence there is a transition to sleep not known to us. In this natural sleep, which is common to all animals, the cause seems to be a deficiency of the nervous spirits, which have been every where largely consumed by the exercises of the muscles and senses, in whose actions there is probably a great quantity of this fluid exhaled.

§ 569. A perfect rest or composure of the mind and external senses, with the absence of all stimulus, or irritation in the head and other parts of the body, joined with darkness, promote and hasten the forementioned steps of sleep, and render it more quiet or profound.

§ 570. Again it is observable, that a variety of causes, which weaken the powers, incline to, and encrease sleep, such as great losses of blood from any cause, bleeding from a vein,
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the use of cooling medicines, or those prepared from the poppy, and cold of the external air; to which add such as call off the quantity of blood flowing to the head, as warm-bathing of the feet, a plentiful ingestion of food into the stomach, &c. Some other things there are, which have a power not only of lessening or weakening the motion of the spirits in the brain, but also in the stomach, intestines, heart, and arteries: such as opium, and perhaps the other strong narcotics.

§ 571. On the contrary again, there are various hot medicines, which induce sleep, by exciting a greater afflux of blood to the brain, such as wine, alcohol, or vinous spirits of all sorts, but more especially when resolved into vapour; to which add, acute and malignant fevers of various kinds, or else such things as retard the return of the venal blood, as fatness, &c. all these causes seem to concur in this, that a greater quantity of blood, being collected in the head, compresses the brain, so as, in a degree, to intercept or lessen the course of the spirits from thence into the nerves.

§ 572. But likewise mechanical causes produce a sleepiness; for if the dura mater and brain be compressed by any cause, whether from extravasated blood, a depressed part of some bone, or a collection of serous water within the ventricles of the brain itself, a comatose or morbid sleepiness is thereby induced.

§ 573. Sleep, therefore, arises either from a simple deficiency of the quantity and mobility

of the spirits, or a compressure of the nerves, but always from a collapsing of the nervous tubes, through which the nervous spirits pass out from their fountain, in the common sensory, to all parts of the body.

§ 574. This theory is likewise confirmed by the causes of vigilance; for all those things prevent sleep, which produce plenty of spirits, more especially warm aromatic drinks, which send plenty of minute stimulating particles to the head, by which the motion or course of the blood is moderately quickened through the brain; and being, at the same time, more dilated, makes a larger secretion of spirits, in a given time.

§ 575. Sleep again is hindered by cares of the mind, meditation, study, and passions of a stronger degree, with pains of the body and mind; all which hinder the spirits from resting in the common sensory, or urge them so as to prevent the nervous tubes from collapsing. Therefore, as the former increase the quantity of the spirits, these causes increase their motion. And, therefore, again the same conclusions are to be made from hence as before (§ 573.) namely, that the nature of sleep lies in a collapsing of the nerves, which go out from the common sensory.

§ 576. If it be enquired, whether the seat of sleep be not in the ventricles of the brain? we answer, that it is not consistent with the ample bounds or dominions of sleep; which extends itself even to such animals as have no ventricles in the brain. Whether or no
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the vital actions continue to be carried on in sleep, for being affections of the brain, independent of the cerebellum? and what may be the cause of this difference, by which the animal offices rest in sleep, while the vital operations are continued? we know not of any other reasons, besides - those before given (§ 400.) that the vital motions are perpetually stimulated into action, from the causes urging a necessity of keeping them from rest.

§ 577. The effect of sleep is a moderation or abatement of all the motions in the human body. For now the action of the heart only remains, by which all the humours are sent through the vessels, at the same time that all the muscles and perceiving nerves, with the passions of the mind and voluntary motions, are removed; by which the course of the spirits was quickened not only to the heart, but to all the other organs, so as to cause wakefulness (§ 552, 419.) Thus the heart is gradually restored from its quick and almost feverish pulsation, to the slow and calm condition in which we find it by the morning; the breathing in sleep becomes slower and smaller, the peristaltic motion of the stomach and intestines, the digestion of the aliments, the sense of hunger, and the progression of the fæces are all diminished; at the same time, the thinner juices move more slowly on, while the more gross and sluggish are collected together, and the fat transfused is accumulated in the cellular substance; the viscid albuminous humour, for the nourishment of parts, adheres

more plentifully to all sides of the fibres and small vessels; the consumption of the spirits, the attrition of the blood, and the quantity of perspiration, are all diminished. Thus, while the quantity of the nervous spirits continue to be secreted with a less consumption, it is, by degrees, accumulated in the brain, so as to distend and fill the collapsed nerves, which, both in the internal and external organs, return again to action by the approach of some small stimulus, by which they are again restored to vigilance. Sleep continued for too great a length of time, disposes to all the disorders that attend a slow circulation, to fatness, drowsiness, weakness, and cachexies; and is, at the same time, highly detrimental to the memory.

§ 578. From whence does yawning attend those that are about to go to sleep? we answer, to promote the passage of the blood through the lungs, which is now slower; and the stretching of the limbs is to increase the motion of the spirits, that they may over-balance the natural contraction of the muscles, by which all the limbs are drawn into a moderate degree of contraction. If it be demanded, from whence came the unjust opinion, which has been so well received, that the motion of the heart becomes stronger in sleep, and the perspiration more plentiful? we answer, that the mistake arose from the increased heat, arising from the bed-cloaths, by which the perspirable matter, being confined, every where conduces to warm, soften, and relax the skin. But any one that sleeps in their usual garments, grows colder; and

and animals, which sleep for a long season together, grow cold externally almost to the degree of the element. From whence is it, that all animals grow sleepy, after taking food? not from a compressure of the aorta, or from a repletion of the head with blood; for even animals, which have scarce any brain, sleep after food. But it proceeds from the force of stimulus, which is exerted by the chyle and air contained in the stomach and intestines, to which a greater flux of spirits and blood, of course follow, as in every other kind of stimulus; whence the brain suffers a considerable abatement. Whether or no there is a perpetual dreaming, so as to be inseparable from sleep? and whether this be natural, so that the mind never ceases to be without thought, as a consequence following from sensation? we answer, this does not seem to be the true state of nature; for dreams we judge to be rather referable to disease, or to some stimulating cause that interrupts the perfect rest of the sensorium. Hence we see, that intense cares of the mind, or the strong impression of some violent idea received in the memory, hard indigestible food, abounding, in its quantity, with any uneasy posture of the body, are the most usual causes that excite dreams; which, if we can rely upon the testimony of our memory, seem always to be absent from a sound and quiet sleep.

LECTURE XXI.

Of Hunger, Thirst, Food, and Drink.

§ 579. **W**E see the Creator has given to man the two faithful guards of pleasure and pain (§ 551.) for his preservation ; the one to avert evil, the other to invite him to useful actions. From hence we are informed, that the taking of aliment is an action necessary and useful to our support. For since every day there is a great quantity wasted from the body, by a dissolution of its true substance, thrown off by the perspiration and other discharges, a repairing of the said loss is every way necessary : but more especially this is demanded from the aliment, by the nature of the blood itself, strongly inclined to a sharp, saline, lixivial quality, and to a putrid acrimonious state, to which it is continually solicited, and approaches from the putrescent disposition of all the more stagnant humours of the animal, promoted by the incessant and natural motion of the heart and arteries, with a perpetual heat. Moreover, the coagulable disposition of the blood, continually losing a great part of its diluting water, by insensible perspiration, calls strenuously for a recruit of the watry element, in the way of drink, by which its cohesive globules are separated from each other, and hindered from running together into a consistent mass.

§ 580.

§ 580. These truths are proved not only from their causes, but likewise by their effects and appearances, which they exhibit in men and other animals killed by hunger; for, in such, we commonly observe a sharp stinking breath, a looseness of the teeth, from the dissolving acrimony of the juices, violent pains in the stomach, a sharp fever, and even a true madness. All these disorders arise sooner and stronger, as the person is more robust and more violently exercised with motion of body; but they ensue very slowly in phlegmatic people, who are unactive, perspire little, and put the blood into no great motion.

§ 581. The fresh chyle, composed, for the most part, out of the acescent class of vegetables, and of a consistence always thinner than that of the blood itself, being received into its torrent of circulation, seems to temperate the putrescent acrimony, to dilute or lessen the coagulation threatened, and reduce the whole mass from a sharp saline to the mild albuminous nature, which is proper to healthy blood; and finally, the chyle, but more especially that derived from the flesh of animals, being replenished with gelatinous lymph, serves to repair the consumption or waste which is made from the body itself, to the vacuities of whose broken solids it is applied, by the causes before-mentioned (§ 240.) But the drink chiefly dilutes the cohesive or grumous inclination of the blood, hinders its putrescent acrimony, and carries off, by the emunctories, such particles as are already putrid; and hence it is, that a

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person may live for a long time without solid food, if he be but supplied with drink, even of water.

§ 582. We are solicited to take food, as well from the sense of pain we call hunger, as from that of pleasure, which is received by the taste (§ 456.) The first of these proceeds, doubtless, from the sensible folds or wrinkles of the stomach, rubbing against each other by the peristaltic motion, joined with a pressure from the diaphragm and abdominal muscles, by which the naked villi of the nerves on one side grate against those of the other, after a manner intolerable. Thus we are effectually admonished of the dangers ensuing, from too long abstinence or fasting, and excited to procure food or nourishment by labour and industry. To this sense also, the gastric liquor or juice of the stomach, collected and sharpened after feeding, does, in some measure, conduce.

§ 583. Thirst is seated in the tongue, fauces, œsophagus, and stomach. For whenever these very sensible parts, which are constantly and naturally moistened by mucous and salival juices, grow dry, from a deficiency of those or the like humours, or are irritated by a redundancy of muriatic or alcalescent salts here lodged, there arises a sense much more intolerable than the former, as thirst is more dangerous; whose uneasy sense continues, until the proportion of diluting water in the blood, being recruited, restores the necessary moisture and free secretion required in the parts before-mentioned. From hence we learn, why thirst attends

tends labour, which exhales a greater proportion of the watry perspiration? and why it is a symptom of fevers? where there is a dryness and obstruction of the exhaling vessels belonging to the tongue and fauces? why simple water, having no tenacity, will often not stick long enough to the juices to abate thirst, which yields, nevertheless, easily to some acid liquors, that not only moisten and render fluid, but also neutralize and provoke forward the humours.

§ 584. From these causes, mortals, being under a necessity of seeking food for the support of life, have, from the beginning of ages, determined their choice to the succulent parts of vegetables and animals, in such a manner, that water and salt seem to be added only as third assistants. And first, it is probable, that the primitive choice of our foods was made by experiments, according as the variety of smells and flavours, in vegetables and their several parts invited, and as the strength or recruit of our faculties thence following, confirmed their utility. But, by degrees, animals increasng, so much as to be incommodious to man, now declining in his constitution or longævity, the flesh of animals was afterwards added, as a better support for those labours, which could not be so well sustained by vegetable food alone. At present, both the number and variety of substances are almost infinite, which we take either as food or seasoning for our nourishment.

§ 585.

§ 585. Although there are many instances of particular persons, and even of whole nations, who have supported life only with one kind of food, either vegetable or animal, or even from a small class of either of them : and although some have lived altogether upon milk or its whey, yet it seems to be necessary, both from the nature and fabric of the human body itself, as well as from the known effects that follow from only one kind of food, that we ought to support life by the two kinds of foods, both animal and vegetable, so intermixed, that neither of them may exceed their reasonable bounds ; and this mediocrity we are taught from the loathing itself, which follows to any one kind of food that has been continued for too long a time together.

§ 586. The flesh of animals appears a necessary part of our nourishment, even from the fabric of the human stomach itself, resembling that of carnivorous animals ; and from the two rows of teeth, with the canine teeth in each jaw ; also from the smallness and shortness of the intestinum cæcum, and from the necessary vigour which we require, and which is more remarkable in carnivorous animals. For it appears, that the flesh of animals only contain the gelatinous lymph, ready prepared for the recruit both of our fluids and solids, which, being extracted from the broken vessels and fibres, is readily converted into abundance of blood. An abstinence from animal food, in those who have been accustomed to it, generally causes great weakness both to the body
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and stomach, being perpetually attended with a troublesome diarrhoea or purging. [But in the amplitude and length of the intestina crassa, man agrees with herbivorous animals.]

* § 587. Esculent vegetables are generally of the acescent kind, only some few of them are either alcalescent, or else replenished with a spiciness; but none of them have that animal glue, which is spontaneously changeable into blood; for it is only the small portion of jelly, which is drawn from their farinaceous parts, which, after many repeated circulations, is converted into the nature of our indigenous juices. Yet these are necessary to avoid overrepletion with blood, and of too putrescent a kind from the use of animal food alone, which, from the most creditable accounts of the anthropophagi, prevails to so great a degree, as to breed the hot alcalescent scurvy, a fierce or savage temper, a stinking and leprosy of the body, with a lixivial corruption of all the juices, which are only to be avoided or cured by change of diet, in which a vegetable acidity abounds. Hence it is, that we are furnished but with few canine teeth, and our appetite in health, but more especially in disease, is stronger for acidulous vegetables, in proportion to our warmer temperature of body, and greater heat of the country or the season of the year. Hence we see, that, in the hottest climates, people live either altogether upon vegetables, or use flesh meats but very rarely, and not without danger of acute diseases; while, in the colder countries, flesh is eaten freely with less danger:
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and hence bread, or something like it, is made a standing part of our food throughout the world.

§ 558. The best drink is afforded by pure water, not incorporated with salts nor with air, by which it may readily enter into a fermentation. Of this kind, we justly prefer that from a mountainous spring, which runs clear and cold through a sandy bed, being very light and insipid. Whenever we are unprovided with such pure and healthy water, as is frequently the case in the lower flat countries, or when any increase of the strength and muscular constriction of the stomach is required, from a spicy stimulus, its place may be very well supplied by wine, prepared chiefly from grapes, but in defect of those, from apples and pears, which, after a due fermentation, becomes clear, and is replenished with an acid salt, and oily or inflammable spirit, well diluted in water. Liquors of the same kind, replenished with a vinous or inflammable spirit, but more flatulent, heavy, and less palatable, are prepared from the several kinds of corn opened by maceration and slight roasting, afterwards extracted with boiling water, and prepared, by fermentation, as a substitute for wine to those countries where the grape does not ripen.

§ 589. But mankind has invented various pickles and sauces, such as salt, vinegar, and acids of various kinds, to correct the putrescent disposition of flesh meats, with pepper, mustard, and other hot spices, to strengthen the action of the stomach, which is perpetually weakened by

by flatulent vegetables ; and to these add, the sugar, salt, and eastern spices, which are generally added either for the sake of flavouring or preserving our food. But all these yield no nourishment, being destitute of all gelatinous lymph, or any farinaceous quality.

§ 590. The aliments are generally dressed, or variously prepared, according to their different nature, the country, season, &c. by which their crudity is removed, their solid fibres softened or opened, their too much incorporated air expelled, or their disagreeable acrimony reduced or changed to a flavour that is agreeable. But even after this, many vegetable foods, and more especially flesh meats, require to be divided, in some degree, by a previous triture in the mouth, which is more especially necessary in man, whose stomach is very thin, or but little fleshy, and likewise that the food may not stay so long upon the stomach as to become putrid. [Therefore we are naturally led from the consideration of the aliments themselves, to that of their mastication.]

LECTURE XXII.

Of Mastication and the Saliva.

§ 591. **S**UCH hard and tough foods, as consist of long parallel fibres, or are covered with a bony shell or cartilaginous skin, generally require mastication, to divide them into less cohering parts, that they may more easily yield their nourishment to the dissolving powers of the stomach. The more diligently they are subdivided in the mouth, the more relishing and agreeable they become to the stomach; the nearer do they approach to the nature of a fluid, and the more easily are they digested or assimilated.

§ 592. Therefore we are provided with a variety of teeth, extremely hard, but planted with a root that is indeed bony and hollow; since it receives, through a small hole in the tip or point of each fang, little blood-vessels, and a nerve, which go to form its internal periosteum: and this whole root, being fixed into a socket of the jaw conformable to itself, is, in the upper part towards its crown, strongly surrounded and tied down by the adhering gums. But the crown, or upper part of the tooth, placed above the gums, is not bony, but a peculiar sort of enamel, of a harder denser substance, and almost of a glassy texture, composed of straight fibres vertical with its root, and running together towards the middle.

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This last portion of the tooth, having neither periosteum nor vessels, perpetually grinds away, and is as often repaired again by a kind of petrifying juice, that ascends or filters from the cells of the root, by which mechanism they are, therefore, supplied with a great degree of hardness, very fit to overcome that of other bodies, and to grind the food with their unequal surfaces.

§ 593. As the materials of our food are various in their texture and firmness, nature has accordingly made our teeth variously figured. In us, the anterior or incisive teeth are four in each jaw, weaker than the rest, and fixed by a single root, upon which stands a crown inwardly concave, outwardly convex, and terminated by a gradual extenuation, like a wedge or chisel, with a rectilineal edge, the office of which, as their name imports, is only, in the softer foods, to cut those which are tougher than the rest, into smaller portions, such as the fibres and membranes of animals and vegetables, with the brittle seeds and kernels of fruits.

§ 594. Next to the former, come the canine teeth, which are two only in each jaw, fixed by a longer and stronger, but single root; from whence their crown is extenuated into a cone. These lacerate tough aliments, and hold fast such as require a longer triture by the grinders.

§ 595. The third order of the teeth is, that of the molares, which, in general, are composed of several roots, with a quadrangular crown, somewhat flat surfaced, but more or

less divided by rocky asperities. The two foremost of these are weaker than the rest, inserted by two, or often but one root, with the surface of their crown parted into two; but the three posterior grinders are larger, fixed by three, four, and sometimes five roots, but terminated in their crown by only one surface, somewhat square and flat, but less in the lower than upper jaw, and is subdivided into a number of eminencies corresponding to that of their roots. Betwixt these teeth, the most compact or bony foods are interposed and broke, as the more tough and hard are ground smaller, while the lower teeth are urged obliquely and laterally against the moveable upper ones; and these are the teeth which perform principally what we are to expect from mastication of food.

§ 596. That the teeth might break or grind the food with due strength and firmness, the uppermost are fixed into the sockets of the immoveable upper jaw, as the lower ones are into the lower moveable jaw, which is a single bone, and so joined with the temporals, that it may be drawn down from the upper jaws, and pulled up against them with a great force, and may be moved laterally to the right or left, forward and backward. Those various motions of the lower jaw depend upon the articulation of its oval heads, in which the lateral parts of the jaw terminate, convex or highest in the middle, and received betwixt the oblique protuberances of the temporal bones, in a shallow excavation, at the root of the jugal process,

cess, deeper in its middle, and increased by a little excavation of the same kind before the auditory passage; from which it is separated by a peculiar fissure. This joint has the freer liberty in moving, and its incruusted cartilages have a longer duration, by the interposition of a small cartilaginous plate, betwixt the condyle of the jaw and tubercle of the temporal bone, concave in its middle above and below, with rising sides, which surround the tubercle of the temporal bone upward, the condyle of the jaw downward, and corresponds to the adjacent inequalities.

§ 597. The muscles moving the lower jaw, which are weaker in us than in brutes, are the *temporalis* and elevator, arising from a large part of the side of the skull, and from the outward tendinous expansion of it, the stellated fibres run together into a tendon, fixed to the coronal or sharp process of the jaw; the *masseter* and elevator, having two or three distinct parts or less muscles, descends from the os jugalis and margin of the upper jaw backward into the angle of the lower jaw. Both the temporal muscles, acting together, pull the lower jaw backward, as the masseters do forward. The *pterygoideus internus* descends from the pterygoide fossa and from the palate bone and root of the hook, with the internal wing, into the angle of the lower jaw, which it elevates or draws to one side or the other alternately. The *pterygoideus externus* has a double origin; one transverse from the inner wing and adjacent bone of the palate, with the posterior

convexity of the upper jaw, the other, descending, arises from the hollow temporal part of the great wing of the sphenoides; thence it proceeds backward and downward into the outer part of the condyle of the lower jaw, which it moves laterally, and draws forward before the upper jaw.

§ 598. The lower jaw is depressed, so as to open the mouth by the digastric or biventer muscle, arising from an hollow of the mastoid process; from whence descending, its middle tendon is tied by a tendinous plate of the cellular substance to the os hyoides, and being likewise connected to the mylohyoideus, and then passing through the divided fibres of the stylohyoideus, it is increased by another fleshy belly, inserted at the symphysis of the two halves of the lower jaw, within the chin. Moreover, the mouth may be partly opened by all the other lower muscles of the jaw, os hyoides, and the larynx, as the geniohyoideus, genioglossus, sternohyoides, sternothyroides, coracohyoides, and latissimus colli; although the latter rather draws the skin of the neck and face downward than the jaw itself.

§ 599. The lower jaw is elevated with a great force, so as to divide the food by the pressure of the upper and lower teeth against each other, by the action of the temporal, masseter and external pterygoide muscles; the contraction of which appears, by experiments, to be very powerful, sufficient to raise several hundred weight. The lateral and circular motions of the jaw, upon one of its condyles.

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removed, are performed by the external and internal pterygoidei, acting either alone or together with the former.

§ 600. Thus the food is cut, lacerated, and ground to pieces, and if the mastication be continued diligently, it is, together with the liquors of the mouth, reduced into a kind of pulp. For, during the trituration of the food, there is continually poured to it a large quantity of a watry clear liquor, evaporable or insipid, or at least, but little saline, and replenished with but little earth, in an healthy state, neither acid nor alkaline, although from thence may be obtained a very small portion of a lixivial salt; and this liquor flows under the denomination of *saliva*, from numberless springs each way surrounding the food. A large quantity of this saliva is separated by numberless small glandules of the lips and cheeks, of an oval figure, which pour out their secreted liquor through short ducts and oblique mouths. This liquor always abounds in the mouth, but in a greater quantity and sharper in those who are fasting; and, being naturally swallowed without our notice, makes a most useful addition to the juice of the stomach itself; nor can this be lavishly wasted by spitting, unless in phlegmatic persons, without prejudice to the constitution. The juice, poured out from the exhaling vessels of the tongue, mouth, and cheeks, is of the like kind, or rather more watry. As for the ductus incisivus, we are now sufficiently certain, that it is blind, or discharges nothing into the mouth, only gives

passage to an artery from that of the palate into the nares.

§ 601. But there are other more considerable salival glands, which supply the watry humour called after their own name. Of these, the principal is the parotid, filling up a large interval betwixt the auditory passage and the lower jaw, to which it is immediately contiguous in the part uncovered and to the masseter; it is a conglomerate gland made up of round or grape-like clusters, connected by the cellular substances; which last, being densified and reticulated, forms an almost tendinous covering, that surrounds and connects the whole gland. From this ascends a white, vascular, capacious duct, to the os jugale, from whence it is transversely inclined, and takes in, by the way, a small duct of a solitary glandule on the top of the masseter, or else lodged distinct, or continued upon the parotid itself, and is rarely double; after this, the duct, bending round the convex edge of the masseter, opens with an oblique or cut aperture through the departing fibres of the buccinator muscle, in the midst of many little glandules of the cheek, over-against the root of the middle grinder. The bulk of this gland, and the number of its arteries, prove it to be the chief spring from whence the saliva flows.

§ 602. Another small gland, adjacent to the parotid, but much less, composed of softer and larger bunches, connected by the like cellular membrane, is, from its situation at the lower angle of the jaw, called maxillary, being in
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part terminated only by the skin, but in part sends off an appendix over the mylo-hyoide muscle, which, following the long hollow side of the lower jaw, of a granular fabric, is spread under the membrane of the mouth, by the name of *sublingualis*. From the larger maxillary, together with this appendix, a duct passes out, which, being a long way covered in its middle part by the sublingualis, receives one, two, or three branches, by whose insertion it goes on, increased to a cylindrical projecting orifice, under the bridle of the tongue. But there are still other small and short ducts from the sublingual glands, from the number of three or four to twenty, which pour out a saliva through short little ducts, or points, under each edge of the tongue. There are some instances where the larger anterior branch of the duct of the appendix, which usually joins itself to the maxillary gland, goes on single, parallel, and opens by itself. Various other salival ducts have been mistakenly published by different professors, which are not confirmed by anatomy herself.

§ 603. The Creator has wisely provided, that, by the motion of the jaw in mastication, the salival glands shall be compressed by mechanical necessity, so as to discharge their juices then to the mouth in greater plenty. For when the mouth is opened, the maxillary gland, being pressed by the digastric and mylo-hyoideus, throws forth a fountain of saliva, as the parotid also does in the same manner, when urged by the turgescence of the masseter; and it is this

muscular pressure, urging the saliva into the mouth, that excites the appetite or mouth-water.

§ 604. The food, therefore, being in this manner ground betwixt the teeth, and intermixed with the saliva and air, into a soft juicy pulp, pliable into any figure, and replete with frothy or elastic air globules, does, by the action of the latter, undergo a farther dissolution, by the warmth of the parts, exciting the elasticity of the air, to expand and burst asunder the confining particles of the food, betwixt which it is included. In this act of mastication, the oily, aqueous, and saline parts of the food are intermixed the one with the other; the smell and taste of different ingredients are lost in one, which by the dilution of the saline parts with saliva, renders the food flavourable; but such particles as are more volatile and penetrating, being directly absorbed by the bibulous vessels of the tongue and cheeks, enter straight into the blood-vessels and nerves, so as to cause an immediate recruit of the faculties.

§ 605. But the motions which are necessary for turning round the food, applying it to the teeth, and conveying it through the different parts of the mouth in mastication, are administered by the tongue, cheeks, and lips. And first, the tongue being expanded so as to form a small concavity in its back or surface, takes up the food thus prepared, and conveys the charge by the moving powers before described (§ 451.) backward to the parts for which it is designed. At one time the tongue rendered narrow by lateral contraction, searches every
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part of the mouth with its tip, and turns out the latent food into a heap, on its common concavity. At another time, applying its extremity to the fore-teeth, and raising itself up successively, it draws the juices from the cavity of the mouth; and, together with the food, conveys them to the fauces or back part of the mouth behind the teeth.

§ 606. But these motions of the tongue are likewise governed by the muscles and membranes, largely inserted into the *os hyoides*, the basis of which is internally concave, from whence are extended horns laterally and outwards, terminated by more protuberant heads, and completed with little oval cornishes; and this bone being drawn down by its respective muscles, depresses the tongue at the same time, and the lower jaw likewise, if the muscles of that be relaxed. These depressing powers are the *sternohyoideus*, but arising also in part from the clavicle, extenuated upwards, and striped with tendinous lines; the *sternothyroideus* arising as the former, and broader from the upper rib, which muscle depressing the cartilage to which it is inserted, is under a necessity of pulling down the *os hyoides* at the same times; this is partly intermixt with the *hyothyroideus*, and in part confused with the *sternohyoideus*. Next the *coracohyoideus*, arising from the upper and shorter side of the scapula, near its notch, ascends obliquely, and at the crossing the jugular vein, changes into a tendon, from whence the other belly of the muscle ascends direct to its insertion, into the *os hyoides*, which it depresses,

being in part confounded with the sternohyoideus. The *hyothyroideus*, a little inconsiderable muscle, may be added to the former, by which it is determined.

§ 607. The other powers which elevate the os hyoides, together with the tongue, are its styloglossus muscle, sustained by a peculiar ligament of the upper jaw. 2. The *stylohyoideus*, a weak muscle, often split for the passage of the biventer, and again united into one portion, after adhering to the tendinous expansion of the biventer, is inserted, together with its fellow, into the angle of the basis, and often into the horn of the os hyoides; the second stylohyoideus, when it is present resembles the former, behind which it is placed, arising from the tip of the styloide process, is inserted into the os triticeum, and answers the purpose of a ligament to sustain the os hyoides. These altogether draw the tongue back, but laterally they elevate it. The *mylohyoideus*, arising from opposite sides of the chin, meet together in one, backward, serving to elevate the tongue, and fix it in making various motions. The *geniohyoideus* being a companion of the genioglossus, pulls the tongue forward out of the mouth.

§ 608. But moreover, the muscles of the cheeks variously move the food in the mouth, and by their pressure on the outside of the teeth, urge it into the inner cavity of the mouth, within the teeth, as we see in the buccinators, when the mouth is shut. Others again open the os externum, for receiving the food betwixt the cheeks and the teeth, such as the double headed

ed proper elevator of the upper lip; and the elevator, which is partly common; to which add the zygomaticus, upper and lower; the risorius, triangularis menti, and the depressor, proper to the angle of the mouth, which arising from an excavation on each side, near the socket of the canine tooth, are inserted into the orbicularis of the lips. Others again close the lips, that the food received may not return out of the mouth, such as the orbicularis of each lip, the proper depressor of the upper lip, and the proper elevator of the lower lip, and that which serves in common for the elevation of both. Of these more particular descriptions may be had, from professed systems of anatomy.

§ 609. By these means the food, ground and mixed with the saliva into a soft pulp, collected from all parts of the mouth by the tongue, into the arched space betwixt the teeth, is afterward, by the expansion and successive pressure of the tongue, conveyed backward behind the teeth, and from thence thrust into the fauces; and in this action the tongue is expanded by the ceratoglossi, and genioglossi, and rendered a little concave upon the styloglossus.

LECTURE XXIII.

Of Deglutition.

§ 610. **T**HE tongue being raised by the styloglossi, and broadly applied to the palate, presses the food successively towards the fauces, which at that time only afford an open passage. After this, the thick root and back part of the tongue itself, by the fore-mentioned muscles, and by the stylohyoidei and biventer carried backward, presses down the epiglottis, which stands up behind the tongue, connected therewith by numerous membranes, and perhaps by some muscular fibres. At the same time, the muscles elevating the pharynx, all act together, such as the biventer, geniohyoideus, genioglossus, stylohyoideus, styloglossus, stylopharyngeus, and the other elevators, which now draw the larynx upward and forward, that the epiglottis, being brought nearer to the convex root of the tongue, may be better closed or depressed. Hence it is necessary towards deglutition, for the jaws to be closed, that by this means the biventer may have a firm support; and, together with the muscles already described (§ 607.) elevate the os hyoides. Thus the epiglottis being pressed down or inverted, shuts up and covers the passage very exactly, into the larynx, over which it is extended like a bridge, for the aliment to pass over into the fauces.

§ 611.

§ 611. By the pharynx we understand an ample cavity, somewhat like a membranous funnel, multiform, with a deficiency before extended from the occipital bone before the great opening of the skull downward, along the bodies of the cervical vertebræ, covered above by the middle cuneiform bone, the opening of the nares, and moveable velum of the palate, receiving the tongue and larynx before, and the œsophagus below, so as to form one soft membranous bag, outwardly surrounded on all sides by muscular fibres, internally lined with an epithelium, or continuation of the cuticle, like which it is renewable, but more moist; outwardly it is surrounded with a good deal of cellular substance, more especially in its posterior and lateral parts. By this structure it becomes lax and dilatable, so as to receive all bodies that are pressed by the tongue over the larynx.

§ 612. This muscular bag is dilated in its action (§ 610.) by the powers serving to its elevation, such as the *stylopharyngeus*, sometimes double, from the process of its name; whence descending, it is inserted into the membrane of the larynx, under the os hyoides, and into the cartilaginous edge of the descending thyroideus, after which it is broadly spread through the internal face of the pharynx, together with the following. The *thyropalatinus*, or *staphylopharyngeus* being spread in the form of an arch round the moveable palate, and from thence extended downwards in two columns, on each side the pharynx, form a considerable part of that bag, being also connected by broad fibres

fibres to the thyroid cartilage. That the *salpingopharyngeus* is a true or distinct muscle, I am ready to believe, rather from the observation of other eminent anatomists, than any of my own. As to the *cephalopharyngeus*, I almost despair of finding any, unless you will reckon the strong white plate of the cellular substance, which surrounds the upper part of the pharynx for a muscle. This bag closely surrounds and follows the drink, on each side the epiglottis, above the larynx; and from thence it falls into the œsophagus.

§ 613. That the aliments might not regurgitate into the nostrils, at the time when they are pressed into the dilated pharynx (§ 612.) a moveable velum or palate is interposed: namely, from the sides of the bony palate and pterygoide wings, is contained a moveable expansion, compounded of the membranes from the mouth and nares, betwixt which membranes are spread muscles; being almost of a square figure and pendulous, betwixt the cavity of the nares and fauces, in such a manner, that they naturally leave the former open, and form a concave arch towards the mouth: and from the middle of this is extended a small portion, pendulous, and of a conical shape, before the epiglottis, replete with many small glands, which from its appearance in a diseased state, is called uvula. The elevator of this velum, which is strong, arises from the asperities of the cuneiform bone, behind the spinal foramen; and from a cartilage of the tube descending inward, does with its companion, form an arch, which is moveable

able with the palate itself, so as to be brought into a close contact with the sides of the nares, and with the tubes, that none of the aliment may enter into either of them. But this elevator does not seem to have any considerable action in swallowing; at which time regurgitation into the nostrils is prevented by a constriction of the muscles of the pharynx, together with a deprefsure of the thylopalatini, which then manifestly draw the moveable velum downward, and towards the tongue and pharynx. [Add to these the *circumflexus palati mollis*, which arises a little more forward from the same cuneiform bone, from the internal side of its wings, and from the inner wing, with the cartilaginous end of the tube, broad, and then passing through a notch of the pterygoide hook, changes its direction, and ascends with a radiated tendon, through the upper membrane that covers the velum of the palate, joins with its fellow, spreads over the other muscles, and adheres to the edge of the palate bone. This is able both to open the tube, and to press down the moveable velum of the palate.] So as to make a pressure upon the contents; and from hence the pharynx being contracted like a sphincter, drives down the food, without permitting any part to return back into the cavity of the nares. Hence we see, that when the ~~immoveable~~ velum of the palate is perforated, or otherwise vitiated by disease, the aliments regurgitate into the nostrils, and stop up the Eustachian tubes, so as to cause a deafness.

§ 614. During this endeavour to depress the food by the pharynx, (§ 613.) the velum drawn back and expanded over, is pulled down towards the tongue, by the action of the palatopharyngei, and by the circumflex muscles of the soft palate, (§ 613.). These muscles, together with the glossopalatini, which last are indeed weak, press the velum against the protuberant root of the tongue, and intercept any return to the mouth. After there is no further danger of any part falling into the wind-pipe, the epiglottis is raised up again, as well by its own elasticity, as by the elevation of the tongue itself, by which it is drawn forward. [Lastly, the depressed uvula is raised by the azygos, which arises from the tendons of the circumflexi muscles.]

§ 615. Immediately after this, follows a force urging the food downward, which is exerted by the constrictor muscles of the pharynx, drawing the fore and back parts together, and the muscles which are partly transverse, and partly ascend into the posterior surface of the pharynx. Of these the principal is, the pterygopharyngeus, arising from the whole hook and internal edge of the wing; from whence forming an arch, it is extended upward and backward, largely surrounding the upper part of the pharynx. The mylopharyngeus, partly continuous with the fibres of the buccinator in the middle, betwixt an insertion or adhesion to the bones, arise also in part from an origin of their own, above the last of the grinding teeth, in the lower jaw. These having a course almost

most transverse, surround the pharynx, and draw its back towards the forepart. Next to these follow the geniopharyngei, ascending in two strata of obscure and confused fibres; next the chondropharyngei, of a triangular figure, arising from the officula triticea; the ceratopharyngei, which ascend radiated from half of the horn; the syndesmopharyngei, arising from the horn of the thyroide cartilage, and distinct from the former; to which add the thyropharyngei of both kinds, increased by the fibres of the sternothyroideus and cricothyroideus, with the cricopharyngei, the transverse, ascending and descending. These muscles acting successively from above downward, according to their situation, drive the aliment into the œsophagus: at the same time the depressing muscles of the larynx, coracohyoideus, sternohyoideus, and sternothyreoideus, draw down the larynx forward, and lessening the capacity of the pharynx, urge the food downward. But in this action, as the aliment passes by the posterior rima, or opening of the glottis, the aryarytœnoidei contract the larynx perpendicularly together.

§ 616. As various dry and rough bodies are frequently swallowed, it was necessary for the pharynx to be dilatable, and not so subject to pain as the tongue, stomach, and some other organs; to which end likewise, the great quantity of mucus, which is collected in all parts of the fauces, greatly conduces. Therefore, in general, betwixt the nervous and innermost coat of the pharynx, are placed a great number of simple mucous follicles or cells, of an oval figure,

figure, pouring out their mucus through short mouths, of a soft, viscid, and somewhat watery nature, but ropy or drawing out into threads, whence it abounds more with saline and oily parts, than the saliva itself. These mucous receptacles are most plentiful in that part of the pharynx, which is immediately extended under the occipital bone, where they are disposed in a sort of radiated right lines; and they are likewise numerous in that portion of the pharynx, which is called salpingopharyngeus. But there are likewise other flat and circular follicles, seated in great numbers about the back part of the tongue, as far as its foramen cæcum (§ 448.) into which, frequently, when it forms a long sinus, there are many mucous follicles open, together in common. Other follicles and pores of the same kind are every where seated in the pulpy flesh of the palate, where numerous small glands discharge such a viscid mucus. Moreover, the whole surface of the moveable palate, is of a glandular nature, like that of the pharynx, only the follicles and glandular corpuscles, are here more numerous and thickly set together.

§ 617. Where the pharynx descends laterally from the hook of the bony palate, betwixt the portions of the glossopalatinus, and pharyngopalatinus, are seated the tonsils, of an oval figure, perforated inward with ten or more large sinuses, which open through the membranous covering of the velum extended over them, and by the pressure of the adjacent muscles, serve to discharge a great quantity of a most thick

thick mucus from their sinuses. In like manner, the adjacent parts of the nares, and projecting rings of the tubes, in that side of the epiglottis that lies next to the larynx and the back of the arytenoid cartilages, are also replenished with mucous organs. Lastly, the œsophagus itself on all sides abounds with simple follicles, from whence a mucus is poured out somewhat more fluid. But the larger glandulæ œsophagææ are of the conglobate, or lymphatic kind, and conduce nothing to this mucus. The blood-vessels of the tonsils are supplied from those of the tongue, lips, and pharynx itself; as those of the œsophagus are derived from the branches of the pharynx, upper and lower thyroidals, from the bronchials, and lower, from the aorta itself. The veins of the palate and tonsils being numerous, run together into a net-work, ending in the superficial branch of the internal jugular.

§ 618. The œsophagus, then, is a double tube, of which the innermost is separated from the outer, by a good deal of cellular substance, that may be inflated. The innermost tube of the œsophagus is nervous and strong; being continued from the membranes of the mouth and nares, on its inner side villous, or like fine velvet, but smoother; not fleecy, but of a pulpy consistence, having this innermost lining distinguished from the rest, by a thin cellular substance, in which the small vessels are reticulated with minute glandules interspersed. The outer tube is muscular, and in itself considerably strong, composed of fibres internally continued from the

lower and back part of the cricoide cartilage, which by degrees change from annular to fibres, that are externally longitudinal, and serve to draw up and dilate the œsophagus, against the food, for its reception. But the other internal circular fibres, which are stronger than the former, arise in like manner from the top of the cricoide cartilage, and by their successive contraction against the food, drive it down through the whole long tube of the œsophagus, which descends first in a direct course, a little to the left side of the wind-pipe; but having reached the cavity of the breast, it passes behind the heart, through the cellular interval, that lies betwixt the bag of each pleura (§ 75.); from whence inclining by degrees, a little to the right, it afterwards bends again to the left, to its proper opening, by which its included food passes through the diaphragm (§ 289.) in the interval of time that is betwixt expiration and inspiration: but outwardly, the whole tube of the œsophagus is surrounded by the cellular substance.

§ 619. This upper opening of the stomach, is contracted or compressed in such a manner, by the lower muscle of the diaphragm, in every inspiration, as to confine the food within the stomach, and direct it in every respiration, by pressure, naturally towards the pylorus. By this means, the upper, or posterior orifice of the stomach, is so closely shut, as to confine even wind or vapours within the capacity of the most healthy stomach, from whence they never escape, but by a morbid affection.

LECTURE XXIV.

Of the Stomach, and its Action on the Food.

§ 620. **B**Y the stomach, we understand a membranous vessel, or bag of a peculiar figure, destined for the reception and further dissolution of the food, within the cavity of the abdomen, behind the left false ribs, in general of an oval figure, and like a cask, of a longer diameter transversely than perpendicularly; and this more so, as the person is more adult; but in the foetus it is altogether short and round. But if we consider more accurately, every section of its figure, they will appear circular; although there be a blind or obtuse concavity in its left extremity, from whence it grows wider towards the oesophagus, at whose insertion its light or section is the largest of all, diminishing by degrees thence forward and to the right side, where it terminates, by forming a short bend in a contrary direction to itself, called the pylorus. Thus its situation, in general, appears to be transverse, yet so that the oesophagus enters its posterior side, and the pylorus goes out from it forward to the right side. The middle of the body and ensiform cartilage, thus cover or answer to nearly the center of the stomach. Since its figure is oval, but incurvated, its lower convexity will form a larger pendulous arch when empty; but when full, the middle convexity of the said arch will be raised outward to the con-

tact of the peritonæum, descending before it : on the other hand, the lesser arch, intercepted betwixt the two orifices, will, in this state of the stomach, lie perfectly backward towards the spine, so as to include the small lobe of the liver. Thus the insertion of the œsophagus into the full stomach, will be in an obtuse angle, in a manner parallel with the horizon ; but in the empty stomach it will be almost perpendicular ; and at the same time, the right extremity of the stomach forming the pylorus, which in a empty state, lies bent upward, will, in the full stomach, be bent more backward, so as to descend in persons lying on their back.

§ 621. About the stomach are placed the coadjutant viscera ; and particularly to its large imperforated extremity, is connected the spleen, by a considerable portion of the omentum ; the lesser arch or curvature of the stomach receiving the little lobe of Spigelius, has likewise the left lobe of the liver, largely interposing betwixt the stomach and the diaphragm, which lobe partly compresses the stomach forward, below the margin of which a portion of the stomach lies immediately contiguous to the diaphragm itself, yet so as, by a moderate extension, to lie hid within the bounds of the false ribs : under and behind the stomach, lies the pancreas, extended for a considerable length in an empty space, upon the transverse portion of the colon : again, from the lesser curvature or arch, arises the little omentum, to which is continued the stronger membrane, that connects the œsophagus with the diaphragm ; nor is the large omentum

tum connected to the whole length of the stomach, but leaving a deficiency to the right side near the pylorus, it is continued on beyond the left extremity, into a ligament, which connects the stomach and spleen together. The ligaments, in these parts, are productions of the peritonæum, which receding from the diaphragm, spreads itself over the stomach, so as to form its outermost coat.

§ 622. The fabric of the stomach answers in general to that of the œsophagus, of which it is an expansion, and in some animals has in all its parts the same muscular appearance. (1.) The outermost coat is from the peritonæum, of considerable strength, so as to confine or limit the extension of the rest, and afford a support to the subjacent muscular fibres: this is expanded into the little and great omentum, after leaving the stomach. (2.) The cellular coat lies immediately under the former, more abundant in the origin of the little omentum, where it contains little conglobate or lymphatic glandules, which also holds true of the cellular substance in the great omentum; but it is thinner and much less considerable betwixt the coats of the stomach itself, whence the outer and muscular tunic closely cohere together; in this substance the larger branches of the vessels are distributed.

§ 623. Next in order, appears (3.) the muscular coat, neither easy to describe or prepare. Here, indeed, we see the longitudinal fibres of the œsophagus, coming to the stomach, are detached one from another in all directions or points from the cardia; some of them of more considerable

strength, run on to the pylorus, along the lesser curvature, which by degrees declining from their longitudinal course, descend or spread into a plain of each side, and are in part stretched out through the pylorus itself, into the duodenum, where they gradually disappear. Other fibres, in like manner, of a thinner kind, descend to the great obtuse extremity of the stomach, which has no opening, seated on the left side: and finally, through every section of the stomach, from its blind or left extremity, to the pylorus, are spread concentric circular fibres, which by degrees increasing in their thickness or number, are continued on with the rest of the circular fibres belonging to the stomach: this last makes the most considerable order of the muscular fibres. But the sphincter of the cardia and œsophagus is composed internally of fibres, arising from the left side of the diaphragmatic aperture, and running to the right, passing on each side the gula, which they thus closely embrace, and then degenerate longitudinally till they are lost under the circular or second stratum, near the pylorus. But the ligaments of the pylorus are two membranous detachments, betwixt the two incurvations into which the pylorus is bent, formed by the foresaid longitudinal fibres, which run along from the stomach to the pylorus, and are very closely joined to the internal coat, in their way.

§ 624. Immediately under the muscular fibres, follows (4.) another cellular stratum, larger than the outermost, softer, more easily inflatable, and consisting of larger cells or vesicles than
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what we usually observe, even in the intestines. Within this cellular substance are spread the small vessels, which, coming from the larger branches of the stomach, enter through its muscular coat, and spread internally, by an angular subdivision, after the manner of a plexus. Under this lies (5.) the nervous coat, which is thick, white, and firm, and properly makes up the true nature or substance of the stomach itself, after the manner of other nervous parts : and this is again lined internally with a third cellular stratum, evidently enough to be perceived, whose vascular net-work is much more minute than that of the former, from whence it is derived. Immediately within this, lies (6.) the villous or velvet-like coat, that lines the cavity of the stomach itself, continuous with the external cuticle, like which it is renewable, but of a soft mucous texture, and extended into a very short pile, like that of the tongue, only less conspicuous, and folded into large pleates, which form a star under the œsophagus ; but in the middle of the stomach, these folds are almost parallel with the stomach itself. But, at the extremity of the pylorus, there is a more considerable fold, commonly called *valvula pylori*, which is formed by a production both of the transverse muscular fibres, and of the thicker nervous coat, extended together in the shape of an unequal loose ring, floating towards the duodenum ; this forms a slippery fleshy protuberance, which surrounds the duodenum for a considerable length. The large wrinkles of the villous membrane are afterwards subdivided more mi-

nutely, into others of a quadrangular or net-like figure; but very shallow, and easily disappearing, being much more obscure than those in the biliary ducts. Within this villous coat of the stomach throughout, but more especially towards the pylorus, I have truly observed some pores, not always to be perceived, which terminate in simple follicles, seated in the next cellular stratum.

§ 625. The vessels of the stomach are both numerous and derived from many trunks or various quarters, that the course of the blood through them might not be intercepted by any kind of pressure, as it might easily have been, if the vessels of the stomach had come from a single trunk. The common mother of all these gastric arteries is the cœliac, from the three-fold division of which, or above the said division, arises the upper coronary, which is the first and largest artery that passes in a single branch round the edge of the œsophagus into the stomach; to which first, and afterwards to the diaphragm and to the liver, it sends off some ramifications, and then running on the lesser arch or curve of the stomach, it inosculates by more than one branch with the lesser coronary of the right side, arising from the right branch of the cœliac at the vena portarum, and is distributed along the lesser curve of the stomach. But the same right branch of the cœliac, after it has descended behind, at the beginning of the duodenal, gives off a very considerable artery that runs along the great arch or curve of the stomach, where, being cloathed with the origin
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of the omentum, it spreads itself both upon each side of the stomach and upon the greater part of the omentum itself, being, at last, inserted by inosculation into the left gastro-epiploica. Namely, the left cœliac trunk, passing along in the direction of the pancreas and sinuosity of the spleen, there sends off many small arteries of various sizes to the stomach; of which the first are commonly nameless, and among the following, one branch, more considerable than the rest, is called the left gastro-epiploica, which sends off a considerable twig to the omentum, with some others that are smaller; from whence, descending round the stomach towards the right side, it inosculates with the right artery of the same name. Other small arterial circles, coming from those of the spleen, are spread upon the greater curve of the stomach, even as far as the diaphragm, under the denomination of the *vasa brevia*. The other smaller arteries are the upper ones of the pylorus from the hepatics, and the lower ones from the gastro-epiploics: but those of the lower part of the œsophagus, are from the phrenic arteries.

§ 626. Those arteries are distributed in such a manner, that first they send off very short twigs to the external and to the muscular membranes of the stomach, as they pass through the first cellular stratum, with which their trunks are surrounded; from whence, diminishing in size, they penetrate through the muscular coat, and within the cellular stratum, betwixt that and the nervous, they compose a larger
and

and truer net-work ; in which all the small arteries, coming from a great variety of trunks, join one with another, by an infinity of inosculations. From this plexus again, other short, but numerous and very small ramifications, pass through the nervous coat to the third or inner cellular stratum, and are lost in the villous lining of the stomach.

§ 627. The veins have their branches distributed, in company with the corresponding arteries. The greater coronary from the left side of the stomach generally goes to the trunk of the porta, together with the brevia and left gastro-epiploic ; while the right vein of the last denomination joins with the middle vena colica, and, together with a branch from the mesentery, pours its contents into the vena portarum. Finally, the right coronary vein belongs to the trunk of the vena portarum itself. All these veins are without valves ; and like the arteries, there are upper coronary veins, with others of the œsophagus from the thorax, all communicating together by inosculations, in such a manner, that there is a free passage for the blood thence into the vena azygos, with which they inosculate.

§ 628. The nerves of the stomach are both large and numerous, produced from the eighth pair, forming two complications about the œsophagus, of which the anterior and less plexus descends through the upper or outer side of the stomach to its greater curve ; and the posterior plexus, which is larger, is distributed through the lesser arch of the stomach ; from whence it passes, together with the arteries, to the liver, pancreas,

pancreas, and diaphragm itself. These nerves may be traced into the second cellular stratum of the stomach, that surrounds its nervous tunic; in which, but more especially in the papillæ, they become obscure or lost. From their number, the stomach is extremely sensible, insomuch, that things, which make no impression upon the tongue, will nauseate and pervert this organ, which is capable of much severer pain than the intestines; as we know from infallible experience in diseases; even the skin itself, when naked by a blister, is less sensible than the stomach. By making a ligature upon the nerves of the eighth pair, both the action of the stomach and the digestion of the food cease.

§. 629. Lymphatic vessels I have observed, sometimes very considerable, about the lesser curve of the stomach, arising from the glands of that part, and inserted by a very large trunk into the thoracic duct. Others, no doubt, arise from small glands of the same kind in the greater curve. That there are other lacteal vessels more than these in the stomach, I have never been able to see, nor am ready to believe; particularly those lately described, and said to pass from the stomach through the omentum to the liver, filled with a true chyle.

§ 630. Within the human stomach, we first meet with a great quantity of mucus, spread upon its villous lining, from the pores before described (§ 624.) which mucus is not unfrequently tinged, by some of the bile returning into the stomach. Besides this, in an empty stomach,

stomach, after fasting, upon bending the body, a great quantity of a limpid or watry humour will arise into the mouth, altogether of the same nature with the saliva; which liquor is very rarely to be found pure or unmixed in the stomach; for if it can be so had, free from any mixture of the food, it is very far from possessing any acid or alkaline acrimony; but, on the contrary, if it be free from any acid or aced relicks of the food, it spontaneously changes both in man and brutes, rather to a lixivial or alkaline nature. This liquor distils from the arteries of the stomach, through its villous coat, after the manner we see by anatomical injections; by which water, fish-glue, and oil, may be easily urged into the vessels of the stomach, so as to sweat through its numberless pores.

§ 631. The stomach then, contained within the abdomen, which is perfectly full, will, from thence, as in a press, receive a force or compressure upon its sides, which lie betwixt the diaphragm; the concavity of whose right wing is filled by the liver, under which, and within the left wing, lies the stomach, extended almost transversely behind the resisting muscles of the abdomen, viz. the recti and obliqui. The more the stomach is filled, the more it is urged by this pressure of the abdominal muscles, because, at the same time, it rises upward, in a right angle, to the contact of the peritonæum.

§ 632. Into the capacity of the stomach are conveyed foods, often crude or in a tough state, and but little altered by the teeth; and these
often,

often, in a variety of kinds or mixtures, some of them being *alcalescent*, as flesh meats; *rancid*, as oily or fat substances; or *acescent*, as bread, milk, and most of the vegetable kind. These, we observe, are digested in an heat equal to that of an hatching egg, administered to the stomach by the contiguous spleen, liver, and superincumbent heart; and this in a cavity altogether close or confined above, as we have seen (§ 619.) as it also is below, by the ascent of the incurvated pylorus, and, in a great measure, by a shutting valve, and likewise constricted by a muscular force of the fibres; from whence we observe, that even milk itself is often retained in the stomach of strong animals several hours after a meal. Observe again, that these aliments are continually cohobated or moistened with watry juices, and, at the same time, are replenished with a good deal of air incorporated with them, either naturally or in the mastication. This air, therefore, expanding by the force of heat, putrefaction, or fermentation, breaks open the cells by which it was included, divides the viscid liquors, and softens or opens the solid fibres, so as to make a way for discharging their juices. But the same substance of the air, turning to a solid, makes the principal glue or cement, by which the animal solids and other bodies receive their firmness; and this, being extricated by heat, leaves the other elementary parts friable or without a vinculum, as we see from the change of bony substances in Papin's digester, in the stomachs of many animals, and even in that of ourselves.

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This air, set at liberty by the digestion, often distends the stomach more than the food itself, under the denomination of wind or flatus. While this air is extricated, the aliments by long stay begin to corrupt or change into a nauseous liquid, either acid, mucous, putrid or rancid, which two last happen less in mankind, from our use of bread, salt, wine, &c. For the truth of which, we may appeal to the flatus and matters eructated, often of a most foetid, caustic, and inflammable nature, from substances of the like disposition. This putrescency, or imperfect petrefaction, is almost the only cause of digestion in fish, serpents, and carnivorous birds. Even in mankind, we see, that metals themselves are, from these causes, eroded and dissolved. At this time hunger is absent, the nervous pleates of the stomach being removed and defended from their contacts with each other by the interposed aliment, at the same time that the juice of the stomach itself is less sharp, and freer from a mixture with the old remains of the last food, which often excite a nauseating uneasiness in the nerves of the stomach.

§ 633. But that the aliment might not degenerate into a complete corruption or acrimony, for the most part of the acid kind, there is a check from the putrescent degree of the heat, the quantity of juices distilling from the stomach, and that of the saliva itself swallowed to the amount of half an ounce in an hour, and rather inclined to an alcalescency: also these juices, being ground together with the

the aliment, macerate, soften, and dissolve the fibres themselves and their cellular bands, leaving them a soft pulp, like what we see, by letting them stand for a long time in warm water. There is, therefore, no particular kind of ferment in the stomach; from which the design of nature, the disposition of the stomach, and its use, are all very remote.

§ 634. The fleshy fibres in the stomach being now irritated by the flatus, weight, and acrimony of the food, begin to contract themselves more powerfully than when the stomach is empty, and with a greater force, in proportion, as it is more full; because the round distention serves the fibres as an hypomoclion or point for motion. And first, the muscular stratum, which passes along the lesser curvature, connects the pylorus with the œsophagus, and, being inserted only into the left face of the former, draws it to the right. The principal stratum of the circular fibres contracts the capacity of the stomach, according to its length, grinds or intermixes its contents, together with the liquors (§ 630.) and determines them both, like the pressure of so many fingers, to flow towards the pylorus: but this flux through the pylorus is not made continually, for reasons before assigned (§ 624.) as well as because this motion begins from some part that is more irritated; and from thence the aliment is driven here upward, as in other parts downward. In this action of the stomach, there is nothing which resembles the triture made by the strong gizzards of granivorous fowls, which some anatomists

tomists have ascribed to the human stomach; which yet has a considerable degree of strength; since the contraction of its fibres is often more than a third part of their length; for we frequently see the stomach reduced to less than a third of its diameter, even to the quantity of a few ounces, with a collapſion of its ſides.

§ 635. But the ſtronger peristaltic motion of the ſtomach, is that which it receives from the diaphragm and muſcles of the abdomen; for, by the preſſure of theſe, the ſtomach is more perfectly emptied by a cloſe approximation of its anterior and poſterior ſides. For it is principally by this force, that the drinks are urged on continually, but the foods only when they are diſſolved, leſt thoſe parts, which are too groſs, ſhould be expelled through the pylorus into the duodenum, when the ſtomach is more that way inclined by repletion; for the ſolid aliments do not ſeem to leave the ſtomach, before they have changed their fibrous or other texture for that of a grey mucus, diſſolving into a yellowiſh and ſomewhat foetid pulp, like a liquid. That which is firſt prepared and turned fluid, goes before the reſt out of the ſtomach; firſt water, then milk, pot-herbs, bread, and laſt of all, fleſh meats, the harder, tougher, and longer ſkins or fibres of which paſs unchanged; but ſuch things or bodies, as are hard, or too large to paſs the pylorus, are retained in the ſtomach for a long time.

§ 636. But a conſiderable portion of the drink is abſorbed by the inhaling veins of the
ſtomach

stomach itself, which open in the pendulous villi, and exert a force like that of capillary tubes or syphons, and are corresponding to the exhaling arteries of the same part (§ 630.); so their contents take a more immediate or short way into the blood, as plainly appears from repeated experiments of injecting the veins. Whether any part may pass into the lymphatic vessels (§ 629.), is doubtful.

§ 637. The stomach, being irritated by too great a quantity or acrimony of the food, or else by sickness, a repulsion of the bile, or other cause, does, by an antiperistaltic or reverted motion of its fibres, drive its contents upward, through the open and relaxed œsophagus, in the act of vomiting. But then this effect is partly from the pressure of the abdominal muscles, depressing the false ribs, and urging the contents of the abdomen against the diaphragm, which, at the same time, contracting itself to a plain downwards, forces the stomach, in a manner, as betwixt the sides of a press, to throw up its contents.

§ 638. But the aliments, drove in their natural course through the pylorus to the duodenum, meet there with the influent bile and pancreatic juice, which often flow back into the stomach. But the former of these, being the principal basis of chylification, will require from us a previous history of the viscera, which convey their blood, through the vena porta, for the secretion or formation of the bile, before we can proceed to enquire into the nature and effects of that powerful humour.

LECTURE XXV.

Of the Omentum.

§ 639. **B**Y the denomination of *peritonæum*, we understand a strong simple membrane, by which all the viscera of the abdomen are surrounded, and, in a measure, sustained. Internally, towards what is called the cavity of the abdomen (but naturally always full) this membrane is smoothly surfaced and moistened with exhaling vapours; but outwardly it adheres to all the parts by the loose cellular substance, which towards the kidneys contains a good deal of fat, but it is extremely thin and short before, betwixt the peritonæum and tendons of the transverse muscles of the abdomen. The peritonæum begins from the lower side of the diaphragm, which it lines, and in certain intervals, joining with the corresponding pleura above, it completes what would be otherwise deficiencies in the diaphragm, as betwixt the ultimate fleshy fibres next the ribs and at the loins; to which add its continuations upward, through the foramina of the diaphragm. From thence this membrane descends, in its fore-part, behind the abdominal muscles; in its back-part, before the kidneys; and going into the pelvis, from the bones of the pubes, it passes over the bladder obliquely backward, and then re-ascends back again over the ureters by two lunar folds or plates,

plates, rejoining upon the intestinum rectum with the former part of itself, which invested the loins, and in the same place, goes next before the rectum.

§ 640. But through this general extent, it sends out various productions or reduplications, for covering the viscera. The shorter productions of this membrane are, in several of the viscera, called *ligaments*; and are all of them formed by a continuous reduplication of the peritonæum, joining their outer surface, together with a cellular substance, interposed and extending to some one or other of its viscera, where its plates separate again from each other to embrace the organ, which they are to surround and furnish with a coat; but the cellular substance always intervenes betwixt this membranous coat of the peritonæum; so that it may be easily distinguished, and, in most parts, separated from the true substance of the organ itself. Of productions of this kind there are three short ones belonging to the liver, one or two to the spleen, and others to the kidneys, lateral parts of the uterus, &c. By this means the tender substance of the viscera is defended from injury by any motion or concussion, and their whole mass is prevented from being misplaced by their own weight, as they receive a sure connexion to the firm sides of the peritonæum.

§ 641. But the most ample and moveable of all these productions from the peritonæum are, those called the mesentery and mesocolon; the description of both which, although difficult in words, ought not to be separated from

that of the peritonæum itself. We shall, therefore, begin first with a description of the *mesocolon*, as being the more simple. In the pelvis, the peritonæum spreads itself within a short compass, and ascends before the rectum; but where that intestine bends into a semilunar curve, the peritonæum there departs out far from the iliac vessels, which lie upon the muscles of the loins, and arises as if duplicated (§ 640.), spreading itself in such a form, as is fittest to receive the colon into its capacity. But above, on the left side, that the colon might be at liberty, it is conjoined to the peritonæum, with little or none of this middle production; spreading itself upon the body of the psoas muscle, as high as the spleen, where this part of the peritonæum, that gave a coat to the colon, spread under the spleen, receives and sustains that viscus, by taking it into its capacity or folds.

§ 642. From thence the peritonæum at the pelvis ascends upward, expanded before the left kidney, and stretched outward on each side, forwards from that and from the right kidney, before the great blood-vessels, under the pancreas; to which, being continuous, it forms a long production, called the *transverse mesocolon*, which, like a partition, divides the upper part of the abdomen, containing the stomach, liver, spleen, and pancreas, from its lower cavity, filled by the intestines. The lower plate of this transverse production is single, continued from the right to the left mesocolon, and serves as an external coat to a large portion
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of the lower and descending part of the duodenum, but the upper plate, taking a more obstructed course, departs in its way from the bottom of the pylorus, and gives an external lamella to the duodenum; before which, and before the colon, it extends backward, and joins with the lower plate in such a manner, that a large part of the duodenum lies within the capacity of the mesocolon. Afterwards, near the liver, the mesocolon bends itself inward, and descends laterally over the kidney of the same side, so as to include the right colon, which is much shorter than the left, even as far as the blind worm-like appendix of the cæcum, resting upon the iliac muscle; to which appendicle of the cæcum a peculiar long detachment adheres, as a beginning to the mesentery. Thus is the mesocolon terminated almost near the bifurcation of the aorta.

§ 6. 3. From thence forward the mesentery follows, as a broad pleated production, continuous with the transverse mesocolon, and extended on the right side forward and downward from the emerging duodenum; and then from the left or long mesocolon, even as low as the pelvis. Thus the mesentery is formed by the plates of the peritonæum, which lie upon the aorta, extended forward and together, under the right portion of the transverse mesocolon; and descending obliquely under the pancreas, it receives or contains the long series of the small intestines, within its capacity, disposed in numberless serpentine folds.

§ 644. The whole seat and extent of the mesentery and mesocolon hold a useful portion of fat, collected commonly more in proportion as they go longer within the capacity, that is necessarily formed by the reduplication of their membranes, or plates of the peritonæum; whence serves as a stratum or bed to the vessels, while some portion of the fat, which was separated from the arteries, is absorbed again by the veins, in the manner we shall hereafter observe.

§ 645. The structure of the omentum answers very nearly to that of the mesentery. But there are many membranes that come under this general denomination of the same structure and utility, all composed of very tender and fine membranes, easily lacerated, betwixt which the blood-vessels are disposed reticularly, with fat deposited in streaks near the sides, and in the same directions with the reticulated vessels themselves. The omentum is always a double membrane, the two plates of which are joined together closely by a very tender cellular substance, within which the vessels are distributed, and the fat collected. And first, where the top of the right kidney and the insulcated lobe of the liver, together with the subjacent blood-vessels, meet with the duodenum into an angle, there the external membrane of the colon, which comes from the peritonæum, joining with the other membrane of the duodenum, which is also from the adjacent peritonæum, go together over the left kidney backward, and enter into the transverse fissure of the liver, for a considerable length;

length; from which the external membrane is continued over the gall-bladder which it contains, confirming the vascular fabric of the liver, very slippery, and tinged of a yellow colour. Behind this membranous production, betwixt the adjacent duodenum, right lobe of the liver, and hepatic vessels, lies a small natural opening, by which inflated air is largely received into all that cavity of the omentum which we shall presently describe as a bag.

§ 646. From thence in a course continuous with this membrane (§ 645.) from the pylorous and the less curve of the stomach, the outer membrane of the liver joins, in such a manner, with that of the stomach, that the thin membrane of the liver is continued out of the fossa of the venal duct, before the little lobule of Spigelius, into the stomach itself, stretched both before the lobule and before the pancreas. This is called the little omentum hepatico-gastricum; which, inflated, resembles a cone, and, hardening, by degrees, when it is without fat, changes into a true ligament (§ 621.), by which the œsophagus and liver are conjoined together.

§ 647. But the great *gastrocolic-omentum* is of a much larger extent. It begins at the first joining of the right gastro-epiploic artery to the stomach, where it is continued from the upper plate of the transverse mesocolon (§ 641.), and from thence it proceeds forward along the great arch or curve of the stomach to the spleen, and, in part, is continued also from the right convex end of the stomach towards the spleen,

even till it degenerates into a ligament, that ties the upper and back-part of the spleen to the stomach. This is the *anterior leaf* of the omentum.

§ 648. This anterior leaf, or lamina of the omentum, floats loosely downward before the intestines, often to the navel, sometimes to the pelvis, behind the peritonæum and muscles of the abdomen, and, making a thin edge, is folded back again upward, so as to form another leaf behind, and, like to the former, leaving an intermediate free capacity, by which the fore leaf may easily remove from the posterior, as a sheet of paper is commonly folded, being at length continued for a considerable extent into the outer membrane of the transverse colon, and lastly terminated in the sinus of the spleen, by which the large blood-vessels are received. Behind the stomach and before the pancreas, the cavity of this is continued into that of the lesser omentum.

§ 649. To the former is continued the omentum colicum, which arises on the right side only from the colon and its external membrane, immediately after the origin of the omentum gastrocolicum from the mesocolon, with whose cavity it is continuous; and, departing doubled from the intestine, forms a production, ending conically, and terminated by a longer or shorter extent, above the *intestinum cæcum*.

§ 650. Lastly, from the whole tract of the colon, stand out little protuberances or omenta, called *appendices epiploides*, which are of a like fabric, and, when inflated, resemble
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close or confined bladders; being continued of, a small size and oblong figure, from the outer membrane of the colon, well filled with fat.

§ 651. The uses of the omentum are many. Its common use is, together with that of the mesentery, to form an ample space of a loose texture, into which the fat may be poured from the arteries, at the time of sleep and inactivity of body, to be afterwards dissolved by motion, and returned again into the blood by the insorbent veins, so as to make a constituent principle of the bile. Accordingly, you will feel the fat of the omentum to be very tenacious or viscid betwixt the fingers, although of a thin consistence, and, in its whole body, more pellucid than paper. For that the fat of this part returns again into the veins, appears from the different bulk and weight of fat, observable in the various omenta of different persons, according as they lead either an idle, laborious, or morbid course of life. To which add, its appearances in various brute animals, with the relation it bears to all the rest of the fat of the whole body (§ 21.): and, by experiment or example in frogs, where this re-absorption of the fat may be made evident to the eye; and lastly, from the apparently inflammable nature of the bile itself. Hither we must also refer the disorders and crudities of digestion, together with the coldness of the stomach, observed to follow after cutting out the omentum, and the other uses following (§ 656, &c.)

§ 652. But that the absorbed fat goes from hence to the formation of the bile, appears by
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the course of the blood, which all returns from the omentum and mesocolon into the trunk of the vena portarum, and by that into the liver itself. The omentum is furnished with blood by the gastrocolic and by each of the gastro-epiploic arteries, descending in many small branches, and subdivided in a reticular manner: of these, the arteries on each side run to the greatest length; but the inner or posterior leaf of the omentum has small arteries, which go out from those of the transverse colon. The omentum colicum has also its arteries from the colon, in the same manner as the smaller appendices (§ 650.) The arteries of the lesser omentum (§ 646.) come from the hepatics, also from the right and left coronaries of the stomach.

§ 653. The nerves of the omentum are very small, as being a fat and indolent body; yet it receives some little branches from the nerves of the eighth pair, both in the greater and in the lesser curve of the stomach.

§ 654. The arteries of the mesentery are, in general, the same with those that go to the intestines, the smaller branches of which go off laterally to the small glandules and cellular fat, included within the mesentery. But to the mesocolon, small arteries are distributed on all sides from those of the various parts connected to it, as the intercostals, spermatics, lumbals of the renal capsules, and transversely from the splenic artery, with the pancreatic branch of the duodenum: but in the left mesocolon, there
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are also small arteries detached from the aorta itself to the glandulæ lumbales.

§ 655. The veins of the omentum, in general, accompany the arteries, and, like them, unite into larger trunks; those of the gastrocolic omentum from the left side open into the splenic, as do those of the hypaticogastric, which likewise sends its blood to the trunk of the vena portarum; those from the larger part of the right gastrocolic omentum go to the mesenteric trunk, as do those of the omentum colicum, with those of the appendices epiploides. All the veins of the mesentery meet together in one, which is truly the trunk of the vena portarum; in forming which, they are first collected into two large arms, of which one receives the mesenterico-gastro-epiploica, with the colic and iliocolic veins, and all those of the small intestines, as far as the duodenum; the other arm, which goes transversely across the former, which arises above it, is embraced by the duodenum, and returns the blood of the left colic veins, with those of the rectum, except the lowermost, which belong partly to those of the bladder, and in part of the hypogastric branches of the pelvis. The vein, which is commonly called hæmorrhoidalis interna, is sometimes inserted rather into the splenic than into the mesenteric vein. If it be demanded, whether the omentum has any lymphatic vessels? we answer, in the affirmative: since there are conglobate or lymphatic glands, both in the little omentum and in the gastrocolicum; also the antient anatomists have observed

observed pellucid vessels in the omentum, and lately a modern has described them for lacteals of the stomach.

§ 656. Other uses of the omentum, which may be added to the preceding (§ 651.), are to interpose betwixt the intestines and peritonæum, which, by inflammation, are very apt to grow together; to keep the former in a state of free motion, as well among themselves as against the peritonæum, with but little attrition; and to anoint the muscular and membranous fibres with a most soft oil. For these reasons, even in insects, there is a great deal of fat placed round the intestines. In the large intestines, there are a great many appendices of fat, like that of the omentum, which is not ample enough to cover the colon, whose muscular stripes or portions are larger and more powerful than those of the other intestines.

§ 657. More than this, the stratum of the omentum serves to support, direct, and distribute the vessels to connect the adjacent viscera, and to exhale a soft oily vapour, which, mixing with the exhaling water of the abdominal viscera, serves to anoint and lubricate them all for an easy motion.

§ 658. The mesentery serves to suspend and display the intestines in such a manner, that they may move freely, and with a degree of firmness; it serves as a bed to sustain, and safely conduct the numerous vessels, nerves, and glandules; of which last, we shall speak hereafter (§ 721.): it also gives an external coat

coat to the intestines, and forms most of the omenta.

§ 659. But, moreover, the blood, returning through the mesenteric and mesocolic veins, brings with it another principal constituent part of the bile, and in a considerable quantity; namely, a subalcaline watry humour, which is absorbed by the veins from all the small intestines, as will be demonstrated in its proper place. Besides this, there is a more putrid water absorbed from the large intestines, which is foetid, and nearly approaches a volatile alkaline nature, as may appear from the nature of the faeces themselves, from whence it is absorbed; and it is likewise manifest from the greater compactness and dryness of the faeces, when they are retained a longer time in the colon. This saponaceous water is, therefore, a fluid in itself, and rendered more so by an incipient putridness; and consequently it serves to reduce the tenacity of the oil belonging to the omentum and mesentery, so as to keep it from congealing. But more especially in the bile, it constitutes the acrid alkaline quality, with which this humour abounds; and from thence comes the great tenuity and saponaceous force of the bile, so useful to dyers and painters.

LECTURE XXVI.

Of the Spleen.

§ 660. **T**HE spleen itself is one of those intermediate viscera, which send their blood to the liver. It is a blueish, pulpy, somewhat oval viscus, something like a mass of congealed blood in its consistence, having frequently a notch or incisure in its oval circumference; whence it is convex towards the ribs, concave inwardly, and circumscribed with two margins or edges, one anterior, the other posterior; of which the former, with a full stomach, lies next the diaphragm, and the latter upon the left kidney. It is connected to the stomach by the little omentum (§ 646.), and above that, by the ligament from the large omentum, supported by the subjacent colon, and by another ligament (§ 641, ult.) behind the renal capsule, to which, and to the kidneys, it adheres by a good deal of cellular substance, with the peritonæum. It also receives the peritonæum from the diaphragm, under the denomination of a ligament in the back-part of its hollow sinus, behind the entrance of its vessels. The situation of it varies with that of the stomach itself, which it follows (§ 620, ult.); for when that is empty, the spleen is raised perpendicularly, so as to place its extremities right up and down; but when the stomach is full, the middle curve or arch of it arises upward or foreward, and at the same time obliges the
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the spleen to change its situation, so as to lie transversely with its lower end forward, and its upper end backward. Nor is the bulk of it less variable; for, being of a very soft and loose texture, it grows larger by distention when the stomach is empty, and becomes less again when its blood is pressed out by the distention of the full stomach against the ribs. From hence the spleen is found large, in those who die of lingering diseases; but in those who die suddenly, and in full health of body, it is small. Another motion of the spleen is, that of descending with the diaphragm in inspiration, and ascending again in expiration; and besides this, the spleen frequently varies in its situation, with that of the colon. Frequently there is a second or less spleen placed upon the former.

§ 661. The blood-vessels of the spleen are large, in proportion to its weight. The arterial trunk comes from the cœliac, the upper branch of which, proceeding in a serpentine course, above and behind the pancreas, to which it gives branches, as well as to the mesocolon, stomach, and omentum, is, at length, incurvated in the direction of the sulcus or notch of the spleen, which it, after a manner, perforates by several distinct branches, sustained at the right extremity by the omentum gastrocolicum. The splenic vein, which accompanies the artery, is considerably softer than any other veins of the body; it forms the principal left branch of the vena portarum. Besides these, the spleen receives small arteries from the great coronary, descending behind the pancreas,

pancreas, and sometimes from the internal hæmorrhoidal. The vasa brevia of the spleen and stomach, we have mentioned (§ 627.); and its ligaments receive small arterial twigs or circles, from the phrenics, intercostals, and those of the renal capsules. In like manner, also the veins in the spleen, and those which join it to the stomach, communicate with the phrenics, and with the veins of the renal capsules.

§ 662. The lymphatic vessels of the spleen, I believe, are oftener talked of than seen; they are described to arise in the duplicature of the splenic coat or membrane (of which there is none at all) and from thence to proceed on to the receptacles of the chyle, very evident in a calf.

§ 663. The nerves of the spleen are very small, from whence it is capable of but little pain, and is very rarely inflamed. They arise from a particular plexus, composed out of the posterior branches of the eighth pair at the stomach (§ 628.), and of certain branches from the large gangliform plexus, which produces the splenic trunk of the intercostal nerve, from whence the branches surround the artery into the spleen.

§ 664. The fabric of the spleen appears to be much more simple than has been commonly believed. For it is composed, both in us, and in calves, altogether of arteries, and of veins; the former of which, after spending themselves in a great number of small branches, are at length thickly subdivided into very soft brush-like bunches, very difficult to fill with injection, terminating in circles, by which there is a ready passage for liquors into the corresponding veins.

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These circles, with their parallel branches, form a sort of bunches, like a pencil brush, but of a shorter rounder kind, whence many have mistaken them for glands. Nor does the injection, rightly managed, ever escape from the vessels into the cellular substance; besides which, there are no other cells or intervals. Every little arterial trunk, with the smaller twigs that proceed from it, are each of them surrounded by a very fine cellular substance, or web-work, in the same manner with the small vessels of all the other viscera; and these together, make up the whole body of the spleen, outwardly surrounded by a membrane, which is not very tough, continued from the peritonæum.

§ 665. Hence we observe, that the spleen contains more blood, in proportion, than any of the other viscera, since it has no muscles, fat, air-vessels, or excretory ducts, interposed betwixt its blood-vessels. We learn also, from observation, that the blood of this part hardly ever congeals; from the abundance of its volatile or bilious salts: but it looks of a dark brown colour, and may be easily diluted; whence one may compare it almost to the blood of a foetus.

§ 666. The want of an excretory duct to the spleen, has occasioned the use of it to be doubtful, and controverted throughout all ages of anatomy. To us the fabrick itself seems to lead to the use following. We see by the vessels a greater quantity of blood is imported to the spleen, (§ 661.) and with a slower motion, from the serpentine course of the artery; but at the time when the stomach is empty, this blood

comes, and is received in a greater quantity by the spleen, not now so much compressed, therein to stagnate, as it would seem, plainly from the great proportion of branches, to the trunks in this part; to which add, the difficult course or slow circulation which the blood meets with in passing from the spleen through the liver: from hence the frequent tumours and scirrhoties of the spleen; and from hence the immense quantity of blood, with which the spleen is in every point distended, like a drum, the like of which we do not see in any other part. Here, then, the almost stagnant blood, fomented with heat, attenuated, and in a manner dissolved by the putrid fæces of the adjacent colon, enters thus upon the first steps of a begun putrefaction, as we learn by experiments, both from its colour and consistence. But the greater fluidity of the blood herein, proceeds not only from this dissolution, but because all its watery juices, that enter by the artery, return also again by the vein; for there are no secretory ducts in the spleen.

§ 667. Moreover, when the stomach is full of food or flatus, the spleen is thereby compressed into a narrower compass, against the ribs, and superincumbent diaphragm, by which means the blood that before was scarce able to creep along through the splenic veins, being now pressed out more plentifully, returns with a greater celerity towards the liver, till mixing with the sluggish blood in the trunk of the porta, replenished with the fat, or oil of the omentum and mesentery (§ 652.) it dilutes or thins the same, and renders it less apt to stag-

nate or congeal ; and at the same time, it conduces to form a larger secretion of bile at a time when it is most wanted, viz. to flow plentifully to the food now under digestion. The spleen, therefore, seems to prepare the blood, that it may supply a sort of watery juice to the bile ; but such as is probably of a subalcaline nature, and rendered somewhat sharp, or lixivial by the remora of the blood.

§ 668. Hence we may be able to solve the question, whether the spleen be like the lungs of a spongy or cellular fabric ? and whether the blood is poured out into those cells, so as to stagnate in its way to the veins ? or whether it be there diluted with some juice secreted by peculiar glands ? We see nothing of this is demonstrable by anatomy ; nor does the liquor or wax injected, ever extravasate into the cellular substance, unless urged with much greater violence, than nature ever uses or intended. If it be demanded, whether diseases do not sometimes demonstrate a sort of glandular fabric in this part, and comparative anatomy the same ? an answer may be had from (§ 185.). As to the old question, whether the spleen brews up an acid, to whet or sharpen the stomach ; that opinion has been long discarded, as repugnant to the nature of all the animal juices. If it be asked whether the spleen be not an useless mass, as it might seem to be, from the little damage an animal sustains, after it has been cut out ? we answer, that a robust animal, suffering but little injury from the loss of a part, does not prove it to be useless : on the contrary,

we experience, after such an experiment has been made, that the liver becomes swelled and disordered, makes a less quantity of bile, and of a darker brown colour, while the animal is perpetually troubled with flatulencies, gripes, or indigestion, all which are to be ascribed to the vitiated nature of the bile, an obstruction of the liver, and an imperfect or weak digestion.

LECTURE XXVII.

Of the Liver, Gall-Bladder, and Bile.

§ 669. **T**HE liver being the largest of all the glands in the body, fills up a very large part of the abdomen in its upper chamber, above the mesocolon; and is yet still larger in proportion, in the fœtus. Above, behind, and to the right side, it is covered by the superincumbent diaphragm, from which it receives the peritonæum for a covering, under the denomination of ligaments, chiefly in three places; namely, first, in a transverse position, from the tip of the ensiform cartilage, a little more inclined to the right side than the middle of the diaphragm, which takes a long course round the convex part of the liver, to the passage of the vena cava, through the transverse sulcus of the liver, from whence the peritonæum descends laterally folded together, of some breadth forwards, under the name of ligamentum suspensorium, which divides the greater right lobe from the lesser left lobe of the liver; and then parting from its duplication, it expands into the proper coat of this viscus (§ 621.) which is white, simple, and thin, like the external coat of the stomach; and under this is spread the cellular substance, by which it is intimately conjoined with the flesh of the liver. To the lower margin of this, joins the umbilical vein, which in an adult, being dried up, leaves only

a small cord, surrounded with some portion of fat. In the extremity of the left lobe, and sometimes at its edge, or convex part, a membrane goes to the liver, from the diaphragm, which in children, and other young subjects, is frequently to the left side of the œsophagus, but in adults to the right side; yet always conjoined both to the gula, and to the spleen, whenever the liver, or this ligament are very large. The right ligament ties the large right lobe, in its back part, to the diaphragm. Betwixt this and the middle lobe, for a considerable way, but without any apparent length, the membrane of the right lobe of the liver is often conjoined by the cellular substance, to the diaphragm; more especially in old subjects, for in the fœtus it is easily separated; and then it continues its course betwixt the suspensory and left ligament, joined as before, with the peritonæum, so as to resemble a ligament. But also from the right kidney, the peritonæum going off to the liver, makes a reduplication like a ligament, and conjoins together the less omentum, with the continued loose productions of the mesocolon (§ 645.) with the liver, stomach, and duodenum; and likewise the said mesocolon, to the pancreas. Thus the liver is suspended in the body, with a considerable degree of firmness, yet so as to be allowed a considerable liberty to move and be variously agitated, raised and depressed, by the actions of the diaphragm.

§ 607. Moreover, the inner concave face of the great lobe of the liver, lies with its forepart before the colon, and in its back part corresponds to the
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the left kidney. The middle sinus of this lobe lies near the duodenum, which is by the gall-bladder tinged yellow; and also lies contiguous with that part that conducts the great blood-vessels. The left lobe extends largely over the stomach, and frequently, especially in younger subjects, goes beyond the œsophagus, into the left hypochondrium. The lobule, in the mean time, adapts itself to the lesser curve of the stomach. But moreover, the pancreas is covered by the liver, and in a manner connected with that to the right renal capsule, by a good deal of cellular substance, (§ 671.). The figure of the liver is difficult to describe. It begins in the cavity of the right hypochondrium, by a very thick solid protuberance, convex towards the diaphragm, and hollow towards the colon and kidney, which make impressions into the liver, distinguishable by small lines or eminencies, continued as a portion to the longer appendix of the lobule. After this, the liver, somewhat like a pyramid, grows slenderer, and thinner, and is at last terminated or extenuated into a tip, almost triangularly, which passing into the left hypochondrium, goes before the œsophagus, in young subjects, as far as the spleen, but in adults it often ends short of the œsophagus. The upper and back part of the liver is every where rounding or portuberant, covered by the diaphragm, and in a large part, which is somewhat flatter, towards the left side, it is placed under the heart: but the lower and posterior surface being variously figured, rests itself upon the duodenum, colon, stomach, pancreas,

pancreas, and right renal capsule. For in the hollow side of the liver, there are several little furrows, which divide the surface into several regions, and which did not escape the notice of the ancients.

§ 672. The principal of these furrows is extended transversely, from the right side to the left, for near two thirds of the liver, beginning slender in the right lobe, and enlarging towards the left. Before this transverse sulcus, there is an excavation in the right lobe for the gall-bladder, and then another for the anonymous lobule; after which comes the fossa of the umbilical vein, extending transversely downward, often covered with a little process or bridge that joins the anonymous to the left lobe; but behind the great sulcus, first towards the right side, there is a slender transverse eminence, growing broader to the right, and moderately hollow, by which the great blood-vessels are conducted into the liver; and this little valley was by the ancients denominated the *portæ*, or gates of the liver. In this place there is a lobule, as I shall describe, that joins to the right lobe; viz. the posterior lobule, which is not very justly called after the name of Spigelius; and this projects obtusely conical, like a nipple, into the less curvature of the stomach. The thick root of this and the former excavated eminence, begins from the convex part of the liver, at the diaphragm, and from thence on the right side, is impressed with an oblique sulcus or furrow, inclined to the right side, for the passage of the trunk of the vena cava, descending from the heart,

heart, in the same direction, to the lumbar vertebræ; and is frequently surrounded by a production of the liver, like a bridge, or even so as to complete the circle, and form a tube. The left end of the lobule terminates another fossa, almost perpendicularly downwards, but inclined to the left, which beginning transversely by one end, terminates at the vena cava, passing through the diaphragm. In this sinus was lodged the ductus venosus in the fœtus, of which there are some remains to be perceived also in the adult. All that lies beyond this to the left, is a single hollow, equally descending, and incumbent upon the stomach, over which it is extenuated to a thin edge.

§ 673. This huge gland is proportionably supplied with very large vessels, and of various kinds. The artery, which is indeed considerable, being the greater right portion of the cæliac, emerges from the trunk forward, and to the right, going transversely, before the vena portarum, and after giving off a small coronary with the pancreatic and duodenal artery, the remaining large trunk goes on and enters the liver, commonly by two branches, of which the left is betwixt the umbilical fossa, the venal duct, posterior lobule, with the left, and the anonymous lobe, also the suspensory ligament; and this inosculates with a branch of the phrenic and epigastric. The right hepatic artery enters the liver lower, covered by the biliary ducts; and having reached the right with the anonymous lobe, there sends off, in one small trunk, the cystic artery, which soon after divides into
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two, and is spread both under and upon the gall-bladder, covered by the common coat of the liver, and supplies not only the gall-bladder and biliary ducts, with its branches, but likewise some part of the liver itself. From the left branch, or sometimes from the trunk of this, arises a superficial artery to the biliary ducts, anonymous lobe, and glandules of the portæ. Besides the cæliac artery, there is frequently a large right branch produced from the mesenterica major, creeping behind the pancreas; and this serves instead of the eighth branch of the hepatic artery from the cæliac. But likewise, the greater coronary, which is the first twig of the cæliac, always gives some ramifications to the left lobe, and to the fossa of the ductus venosus, which last branch is often very considerable. The lesser arteries are those sent to the liver, from the phrenic mamaries, renal and capsulary arteries.

§ 674. But the veins of the liver, contrary to what we observe in any other part, are of two very different and distinct kinds: namely, the venæ portarum, which receiving all the blood of the stomach (§ 627.) of the intestines and mesentery (§ 712.) of the spleen (§ 661.) omentum (§ 652.) and pancreas, at length meet together into two arms or branches; namely, the transverse, splenic, and the descending mesenteric; then unite into one trunk, which ascends large, composed of strong membranes, first a little bent behind the duodenum, where it receives the veins from its right side, together with the lesser coronary, whence going higher
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to the right side, it again divides into two large trunks in the sinus of the lobule (§ 672.) of the liver. Of these two the right, being shorter, larger and bifurcated, receives the cystic vein, and then spreads as an artery through its next lobe. The left runs on through the remaining part of the transverse sinus in the liver, and after giving veins to the lobule, with the anonymous and left lobe, it is incurvated and enters the umbilical fossa, from whence about the middle it immerses and ramifies through the liver. There are some instances, in which the venal branch of the posterior lobule has been sent distinct from the vena portarum.

§ 675. The vena portarum is on every side surrounded with a good deal of cellular substance, derived to it from the mesentery and spleen, of a short, close and strong texture, made firm by the addition of the more dense and strong membranes, which cover the aort itself. Intermixt with this cellular substance, are also many of the smaller vessels and hepatic nerves, which all come together under the denomination of a capsula; but improperly, since it is altogether nothing more than the cellular substance, without one muscular fibre. By this the vena portarum is conducted to the liver, and firmly sustained; insomuch, that the branches being cut, maintain the round lights of their sections. But each branch of this vessel, is again divided, subdivided, and infinitely ramified within the substance of the liver, after the manner of arteries, till they at length produce the smallest capillaries. In this course, every branch
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of the vena portarum, is accompanied with a social branch of the hepatic artery, creeping upon the surface of the vein, and the contiguous hepatic ducts, almost in the same manner as the bronchial arteries usually creep along the ramifications of the wind-pipe in the lungs; while, in the mean time, both the artery and the vein are connected to the branches of the biliary ducts, to which they are continued by a thin cellular substance, like a spider's web. The section of any branch of the vena portarum, is always less than the trunk, from whence it is derived; whence the lights of all the branches together, greatly exceed that of the trunk (§ 36.): from whence follows a great friction or resistance (§ 147.), and a retarded motion (§ 133.), after the same manner as we observe in the arteries.

§ 676. But since the blood is in this manner conveyed through the liver to the branches of the vena portarum, together with the hepatic artery, it must of course be conveyed back again, by some other veins: and therefore, we see, that the extreme branches of the vena portarum, and hepatic artery, inosculate and open into another class of veins, which are *branches of the cava*, which arising from all points of the liver, run together towards the posterior gibbous part of the liver, into branches and trunks, which are at last about ten or eleven in number. The lesser of these trunks, and greater number of them pass out through the posterior lobule of the liver, and go to the cava, through the sulcus, that lies on the right side of the lobule, often

often completed into a circle by a sort of bridge, or production of the liver, from whence they ascend together through the diaphragm, towards the left side. Two or three trunks much larger than the former, are inserted into the same cava, close to the diaphragm, whose veins they often take in by the way. The branches of the vena cava are, in the adult, generally fewer and less than those of the vena portarum; which is an argument that the blood moves quicker, and with less resistance or friction through the hepatic cava (§ 140.); as is the course of the blood into a less light, or capacity, by which it is always accelerated, when there is too a compressing force (§ 140.) As to any valves at the openings of these branches into the cava, I know not of any which deserve to be regarded. The trunk of the vena cava, passing through a foramen of the diaphragm, obtusely quadrangular, surrounded and terminated by mere tendons (§ 289.), is thereby rendered not easily changeable (§ 413.); and having surmounted this opening of the diaphragm, it then immediately expands into the right auricle. The smaller veins of the liver creeping about its surface, go to the phrenics, renals, and azygos; or at least there is a communication betwixt these and the hepatic veins.

§ 677. That the blood is sent to the liver, from all the forementioned viscera of the abdomen (§ 674.), conducted by the vena portarum, to the portæ, is proved by a ligature, by which any vein betwixt the ligature and the parts swells, but the porta itself, above the ligature,

ture, grows flaccid and empty. But that it afterwards goes through the liver to the cava, appears by anatomical injections, which show open and free anastomoses, or communications betwixt the vena portarum and the cava, together with the common nature of the veins going to the cava. Again, the difficult distribution or passage through the vena portarum, like to that of an artery, together with its remoteness from the heart, and the oily or sluggish nature of the blood itself, occasion it to stagnate, accumulate, and form schirrous swellings in no part oftener than the liver. But this danger is diminished by the motion of the adjacent muscles, and by the respiration, as it is increased by inactivity, with sour and viscid aliments. But hitherto, we have been speaking of the adult liver, in which both the umbilical vein, and the ductus venosus are empty and closed up, although they continue to cohere with the left branch of the vena portarum.

§ 678. The nerves of the liver, are rather numerous than large, whence it is capable of no very great pain. They have a twofold origin; most of them arising from the large gangliform plexus, made by the splenic branch of the intercostal nerve, with the addition of a branch from the posterior plexus of the eighth pair; they accompany the hepatic artery, and playing round its trunk, are distributed with that and the portal branches, throughout the liver. Another fasciculus of nerves, usually enters with the ductus venosus, and arises from the
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the posterior plexus of the eighth pair, but sometimes from the great plexus.

§ 679. The lymphatic vessels of the liver are numerous, being constantly and easily to be seen about the portæ. They arise from the whole concave surface of the liver and gall-bladder, and run together into a plexus, surrounding the vena portarum, going afterwards to the small conglobate glandules, seated before and behind the said vein, from whence they meet together in one trunk, which is one of the roots of the thoracic duct. Upon the convex part of the liver are described other lymphatics, whose insertion is not well known; but it is hardly probable, that they enter the cava, nor have I been able to find that they lead to the root or cistern of the thoracic duct.

§ 680. The interior or intimate fabric of the liver being more minute, is proportionably more obscure. The ultimate small branches of the vena portarum, cava, and hepatic artery, together with the bilious ducts, which we shall soon describe, are united together by means of the cellular substance (§ 675.) into a sort of mulberry-like bunches, of an hexagonal shape, in the smaller parts of which there are mutual anastomoses, or inosculation, betwixt the portal branches and hepatic artery, with the roots of the vena cava on one side, and of the pori biliarii of the liver on the other side; which last demonstrate their inosculation by anatomical injections; for liquors injected by the vena portarum return again through the ultimate pore or duct of the bile.

§ 681.

§ 681. Many eminent anatomists have taught that the forementioned bunches or primary portions of the liver, are hollow, having arteries and veins, spread upon their external surface, and deposite the bile into their cavity, after it has been secreted from the circles of the vena portarum. For this they alledge arguments, taken from the comparative anatomy of animals, whose liver is made up of more round and definite bunches; and from those diseases, which demonstrate cells and round tubercles, filled with lymph, chalk, or other recrementitious matter. To this they might have added the thick sluggish nature of the bile itself, by which it is related to mucus, and the analogy of the gall-bladder for inspissation.

§ 682. But greater diligence and accuracy in anatomy, will not allow any follicles, into which the small secretory vessels can pour out their contents; for such would intercept the course of anatomical injections, and give us the appearance of knots intermediate, betwixt the secretory vessels and the biliary pores, which we have never yet been able to see; for the wax flows immediately, without any interruption or effusion, in a continued thread, from the extremities of the vena portarum, into the biliary ducts. But again, a follicular or glandular fabric is neither allowable in the liver, from the great length and slenderness of the biliary ducts. For all follicles deposite their contents into some space, immediately adjacent, and are unfit to convey their secreted fluid, to any length of course, which might destroy the part by the velocity

velocity received from the artery. As to the follicular morbid concretions, they are made in the cellular fabric. Another argument against the follicles, is the watery fluidity of the bile, as it comes out of the liver.

§ 683. Again, we are persuaded, that no bile is separated from the hepatic artery, because that would render useless the great arterial trunk of the porta; whose office in secretion, appears plainly by its continuations with the biliary ducts, in a manner more evident than that of the artery: but it appears by experiments, also, that the biliary secretion continues to be carried on after the hepatic artery is tied by a ligature; add to this the largeness of the biliary ducts, in proportion to so small an artery, with the peculiar nature of the blood conveyed by the portal branches, so extremely well fitted for the formation of the bile. For we have already seen, that it contains oil, and lixivium, which abound more in the bile, than in any other humour of the body; for it takes in the saponaceous water of the stomach, by the absorbing veins, together with the subcœtid alkaliescent vapours of the abdomen, which transpire through the whole surface of the intestines, stomach, omentum, liver, spleen, and mesentery, which are absorbed again by the veins, as we know by incontestable experiments of anatomy; and finally, the alkaliescent semiputrid or lixivial humidity that is drank up from the fæces, while they continue to dry in the large intestines, is taken up by the internal hæmorrhoidal veins, from whence that bitterness, alkaliescent,

lescent, and putrescent disposition of the bile is derived. But, on the contrary, in the blood of the hepatic artery, we can find nothing peculiar to the nature of the bile, nor any near relation to it.

§ 684. Since, therefore, the vena portarum conveys the blood ready charged with biliary matter, fit to be secreted in the least acini, or vascular bunches of the liver (§ 683.), and these have an open free passage, without any impeding follicles; it thus flows from the ultimate branches of the vena portarum, into the beginning roots of the biliary ducts, through which the bile is drove by the force of the blood, urging behind, as well as by that of the duct itself, aided by the compressure of the liver against the other viscera, by the motion of the diaphragm in respiration (§ 669.); thence passing through larger branches, it is at last urged into two trunks of the large biliary duct of the liver, which trunks meet together in one upon the vena portarum, in the transverse fossa of the liver, near the anonymous lobule.

§ 685. The fabric of this ductus hepaticus, is made up by a strong nervous membrane, like that of the intestines, over which is spread an external and internal cellular membrane, and is internally lined with a loose villous tunic, elegantly reticulated, but asperated with many small pores and sinuses, and continued with that of the intestine itself. But there is here no muscular fabric apparent.

§ 686. The hepatic duct, thus formed, goes on upon the vena portarum, by the right side
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of the artery towards the pancreas; and then descending to the left, covered by some part of that gland, it goes to the lower part of the second flexure of the duodenum, and is inserted backward, about six inches from the pylorus, through an oblique, oblong sinus, made by the pancreatic duct, together with which it opens by a narrow orifice. The said sinus runs a great way through the second cellular coat of the duodenum, obliquely downward; then it perforates the nervous coat, and goes on again obliquely, next to the villous tunic, which it at last perforates into the duodenum, by a protuberant, long, and wrinkled production, like a papilla. Thus there is almost the length of an inch taken up betwixt the first insertion, and the egress of this duct through the coats of the duodenum, by a sinus, which surrounds and receives the ductus choledocus, in such a manner, that when the coats of this intestine are distended by flatus, or closely contracted by a more violent peristaltic motion, the opening of the duct must be consequently compressed or shut; but when the duodenum is relaxed and moderately empty, the bile then has a free exit. Thus any regurgitation from the duodenum, is hindered by this obliquity, and wrinkling of the duct, easily pressed together or closed, and joined with a quick succession of fresh bile, descending perpendicularly from the liver. Nor does wind inflated into the intestine find any passage into the duct.

§ 687. But in the entrance of the portæ, this common duct receives another less canal of the same kind, which lies for a good way parallel

parallel with itself from the gall-bladder, making its insertion in a very acute angle; and this, which is called the cystic duct, from its origin, is sometimes first increased by another small duct from the hepatic, before its common insertion. This duct is formed by the gall-bladder, as a peculiar receptacle for the bile, given to most animals; but is absent in some, especially those of a swifter foot: it is placed in an excavation of the right lobe of the liver (§ 672.), to the right side of the anonymous lobule, in such a manner, that in infants or children, it lies wholly within the edge of the liver, but in adults projects considerably beyond. Its situation is almost transverse, with its neck ascending from before backward.

§ 688. The figure of the gall-bladder is variable, but in general like that of a pear, terminated in its forepart by an obtuse hemispherical end, which is impervious, gradually diminishing backward; the neck or tip of this truncated cone being inflected upwards against itself once or twice, and tied together by the cellular substance belonging to it, makes then another small flexure upward, and begins the cystic duct, which from thence goes on towards the left side, to the hepatic duct. Within this duct, there are many protuberant wrinkles, formed by the numerous cellular bridles, which tie them together; and these wrinkles conjunctly, in the dry gall-bladder, represent a kind of spiral valve, but being altogether soft and alternate in a living person, they do not stop, only lessen the course of the bile, as we are assured

sured from experiments, by pressing the gall-bladder, and by inflations.

§ 689. The outermost coat of the gall-bladder covers only its lower side, being the common covering of the liver itself, stretched over the gall-bladder, and confining it to the liver within its proper sinus. The second coat is the cellular substance, and of a loose texture. The third coat consists of splendid fibres, chiefly longitudinal; but some obliquely intersecting each other, some circular, and others in various directions. Next to these come the nervous coat, then the second cellular, and last the villous tunic; which are all found here as in the intestines, except that the last, in the gall-bladder, as well as in the biliary ducts, is wrinkled into a sort of reticular folds, as also is the cellular. Within the gall-bladder, but more especially about its neck and middle part, we observe muciferous pores, capable of receiving a horse hair; and besides these, the exhaling arteries discharge some quantity of a watery humour into the cavity of the gall-bladder, as we observe in other cavities.

§ 690. Into this small bladder is deposited the hepatic bile, whenever its course is impeded thro' the common ductus choledicus, or when the entrance into the duodenum is compressed, either by flatus or any other cause. Accordingly, we find the gall-bladder extremely full, whenever the common biliary duct is obstructed or compressed by some scirrhus tumour, whence the gall-bladder is sometimes enlarged beyond all belief; and if the cystic duct be tied

with a ligature, it becomes swelled betwixt the ligature and hepatic duct; and in living animals, the hepatic bile visibly distils into the wounded gall-bladder, even to the naked eye. The retrograde angle, or direction of this duct, is not repugnant to such a course of the bile; for a very slight pressure urges it from the liver into the gall-bladder; and even wind may be easily drove the same way, more especially if the duodenum be first inflated. Nor does there seem to be any sort of bile, separated by the gall-bladder itself. Whenever the cystic duct is obstructed by a small stone, or a ligature made upon it, we find nothing separated into the gall-bladder more than the exhaling moisture, and a small quantity of mucus, secreted from the pores or follicles of the villous coat (§ 689.) beforementioned. In many animals, we meet with no appearance of any gall-bladder, when at the same time there is a plentiful flux of strong well prepared and salutary bile, discharged into their intestines. Again, it does not seem probable, that the branches of the vena portarum can separate bile into the gall-bladder; for that vein in itself is a mere conductory vessel: nor can any be separated from the hepatic artery; for it must be vastly beyond probability, that such a strong bile as that of the gall-bladder should be separated from a milder blood than that of the porta, moved swiftly through the hepatic artery (§ 683.) All the bile, therefore, which the liver sends to the gall-bladder, arrives only through the cystic duct: for in man there are no other ducts betwixt the
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the gall-bladder and the liver : the truth of this we are assured of, by applying ligatures as beforementioned; also from calculous obstructions, with a careful dissection, and exact scrutiny into the parts; by which it appears, that nothing either distils from the liver, or from the gall-bladder; nor are any other vessels wounded besides arteries and veins, when the gall-bladder is enucleated or separated from the liver.

§ 691. Therefore a portion of the hepatic bile being received into the gall-bladder, there stagnates, only a little shook by the respiration; there, by degrees, exhale its thinner parts, which, as we see, filtrate through, and largely penetrate the adjacent membranes. Moreover, being a fluid of an oily subalcaline nature, digesting in a warm place, it grows sharp, rancid, more thick, bitter, and of a higher colour: for this is all the difference betwixt the cystic and hepatic bile; which last we find weaker, less bitter, lighter coloured, and of a thinner consistence, while it remains within its proper hepatic ducts. That this difference betwixt them proceeds only from stagnation, appears from such animals as have only a larger porus hepaticus, instead of a gall-bladder: for here we find the bile, which stagnates in the large hepatic pore, is considerably more bitter than that in the smaller pores of the liver; but in us the gall-bladder gives this particular advantage, that as we take food only at stated times, it can collect it more abundantly from the liver, when the stomach being empty has no call for the bile, that afterwards it may be able to return it in an improved state, when

the digestion of incumbent aliment sollicit a more plentiful and necessary flow of bile into the duodenum; and this flow of the bile is quicker in proportion through the cystic duct, as the section of that duct is less than the section of the gall-bladder.

§ 692. The stomach, indeed, itself, hardly makes any pressure upon the gall-bladder, only by the contiguous beginning of the descending duodenum. But when the stomach is extremely distended, and in a very full abdomen, it makes a considerable pressure both upon the liver and duodenum; by which the gall-bladder is urged, and its bile expressed. Thus the bile flows through a free passage, from the gall-bladder into the common duct, and by that into the duodenum; and this it does more easily in persons lying on their back; in which posture the gall-bladder is inverted, with its bottom upward. Hence it is, that the gall-bladder becomes so full and turgid after fasting. But that the bile coming from the gall-bladder does not flow back again into the liver, appears from the continuity of the cystic and common ductus choledocus, with the angle that interrupts the course from them towards the liver, and the resistance of the new bile, advancing forward from the latter. The expulsive force of the bile is but little more than that of the pressure received from the stomach, diaphragm, and abdominal muscles; for as to any muscular force, residing in the fibres of the proper membrane, which may be thought to contract the gall-bladder, it must be very weak and inconsiderable. But the
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hepatic bile continually flows this way, even after the cystic duct is tied, unless there happens to be some obstacle at the opening of the ductus choledocus, which seldom continues long. Nor is it credible, that all the bile first passes through the gall-bladder, in its way from the liver, before it enters the duodenum; for there is no perpetual obstacle or resistance to turn the bile towards the gall-bladder, out of its high road or open way to the intestine; for the way into the common biliary duct is larger and more direct; but the cystic duct, being a great deal less, even than the hepatic, cannot, therefore, be designed for receiving all the bile nature intended to flow through those so much larger passages; again, the ductus choledocus, being so much larger than either the cystic or hepatic, is, by the same rule, designed to carry more than the bile of either of them alone. In many animals, the hepatic duct conveys the bile into the intestine, without any communication with a gall-bladder or a cystic duct; and, in other living animals, where there is a free communication with a cystic duct, yet the bile is found continually descending into the duodenum. That the quantity of the bile, so discharged, is very considerable, may appear from the bulk of the organ by which it is separated, as well as the magnitude of its excretory duct, so many times exceeding that of the salival glands; and from diseases, in which the quantity of the cystic bile only has, by an ulcer of the side, been let out equal to four ounces at once.

§ 693. The hepatic bile is always bitter, but the cystic is more so; and both of them easily mix, either with water, oil, or vinous spirits, and are extremely well adapted to dissolve oily, resinous, or gummy substances. It is inclined to a putrefaction; but of itself, it naturally degenerates to a musk-like odour. Its chemical analysis, and experiments of mixture with various substances demonstrate, that it contains a large portion of water, but more than a small quantity of inflammable oil, equal to near a twelfth part, which, in stones of a gall-bladder, appears very evidently; besides which, there is no inconsiderable portion of a volatile alkaline salt. The bile, therefore, is a natural soap; but of that sort which is made from a volatile saline lixivium. This, therefore, being intermixed with the aliment, reduced to a pulp, and slowly expressed from the stomach by the peristaltic force of the duodenum and pressure of the abdominal muscles, incorporates them all together; and the acid or acescent qualities of the food are in some measure thus subdued; the curd of milk is again dissolved by it into a liquid, and the whole mass of aliment inclined more to a putrid alcalescent disposition: like soap it dissolves the oil or fat, so that it may freely incorporate with the watry parts, and make up an uniform mass of chyle to enter the lacteals; the surrounding mucus in the intestines is hereby absterged and attenuated, and their peristaltic motion is excited by its acrimony; all which offices are confirmed, by observing the contrary effects from

from a want or defect of the bile. Nor would the hepatic bile of itself be sufficient to excite the necessary motion of the intestines, without the stronger action of the cystic; both which are of so much use and importance to the animal, that we find, by experiment, even the strongest will perish in a few days, if the flux of bile be intercepted to the intestines, by wounding the gall-bladder.

§ 694. Thus it slowly descends along with the alimentary mass, and having spent its force, or changed its bitterness by putrefaction, most of it is afterwards excluded, together with the fæces; but probably some of the more subtle, watry, and less bitter parts are again taken up by the absorbing veins, which lead to the portæ of the liver. It seldom returns up into the stomach, because of the ascent of the duodenum, which goes under the stomach, with the resistance it meets with from the valvula pylori, and the advancement of the new chyle, to which add the force of the contracting stomach itself. The bile is, indeed, of a sweet soft nature in the fœtus; for in them the fæces are not very fœtid, to supply putrid alkaline vapours to the liver, nor are there any oily or fat substances absorbed from the intestines. As the bile is a viscid fluid, and thickens by inactivity of body in fat animals, and in us from the same causes, especially when the blood moves languid from grief; so it easily coagulates into an hard, somewhat refinous, and often stony substance, insomuch, that stones of the gall are much more frequent than those of

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the urinary bladder. When the excretory passages are obstructed by this cause, or by a contrary convulsive motion in the ducts of the liver, the bile is, without much difficulty, urged again into the blood, which passes the capillaries of the porta into the cava, as the way is so pervious (§ 682.); whence all the humours, and the mucous body of Malpighi, become tinged with its colour, which makes a jaundice. Whether or no the common biliary duct is ever truly inserted into the pylorus? This, indeed, is an observation published in the more uncultivated ages of anatomy, the tradition of which has not been favoured by any of the more modern anatomists; although we sometimes read of its being inserted near to the pylorus.

LECTURE XXVIII.

Of the Pancreas.

§ 695. **W**E have already seen, that the bile is a kind of soap, but of a viscid nature, and not sufficiently fluid to make a ready mixture, more especially in the cystic bile; therefore nature has added to the bile a thin, watry, insipid liquor, called the *pancreatic juice*, which is neither acid nor lixivial, poured together with the bile into the intestine, in the same place, that it may dilute, improve, and incorporate with the bile by the peristaltic motion of the intestine, so as to render the whole alimentary mass uniformly mixed, and more apt to move forward; at the same time, it likewise, as a menstruum, dilutes the chyle, and produces the same effects which were before observed of the saliva (§ 604.), together with which, both in the consistence of its juice, and fabric of the gland and its duct, there is an exact agreement, as well as in the diseases. That it also serves to temperate the sharper cystic bile, is also probable, and conformable to the observations of comparative anatomy; by which we learn, that, in those animals who have no gall-bladder, the pancreatic duct opens at a considerable distance from that of the bile.

§ 696. The pancreas is then a very long glandule, the largest of the salival kind, extended

tended transversely above the mesocolon, behind a production of the peritonæum, which, passing over the pancreas, is here continued into the mesocolon; it lies partly behind the stomach, liver, and spleen, before the left renal capsule and the aorta; of a figure somewhat like a trowel or long triangle, of which the upper edge is smooth, and covered with the peritonæum, upon which the posterior flat side of the empty stomach is supported; for that side of the stomach is both lower as well as posterior. The pancreas begins small from the spleen itself, and, extending almost transversely towards the right side, it emerges forewards to the peritonæum across the vertebræ, to the right side of which it grows considerably broad, wrapt up betwixt the superior and inferior plate of the transverse mesocolon (§ 642.), and is finally so connected by its round head to the duodenum, that this intestine serves it for a mesentery. The structure of it is like that of the salival glands, made up by a great number of small bunches of a firm texture, connected to each other by a good deal of cellular substance. The pancreatic blood-vessels are rather numerous than large, derived chiefly from the splenic branches; but on the right side it is supplied by the first artery of the duodenum, and from that which is in common both to the duodenum and pancreas, which last both inosculates with the former and with the mesenteric artery, and not only supplies considerable twigs to this gland, but likewise smaller ramifications to the diaphragm and renal capsule.

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The nerves of this gland are not of any considerable size; whence it is but little sensible: they are derived from the posterior gastric and the hepatic plexus.

§ 697. The excretory duct of this gland runs almost through its middle, white and tender, made up by a great number of lateral branches or roots, by which, being gradually increased, it emerges before the vena portarum and mesenteric artery, and receives a large branch from the lateral pancreatic portion; from whence it advances to the same part of the duodenum, into which the biliary duct opens, where, changing its course downward, it enters through the sinus, that lies betwixt the coats of the intestine, internally smooth; and here, receiving the ductus choledocus, it opens together with that (§ 686.). But not unfrequently it opens distinct, both in its duct and orifice, from that of the biliary duct; and sometimes it is inserted by two ducts, of which the lower one only is distinct and less; but they always open near or within a small compass of the neighbouring duct of the bile.

§ 698. The quantity of juice, secreted by this gland, is uncertain; but it must be very considerable, if we compare the bulk or weight of it with that of the salival glands; than which it is three times larger, and seated in a warmer place. 'Tis expelled by the force of the circulating juices, with an alternate pressure from the incumbent and surrounding viscera; as the liver, stomach, spleen, mesenteric and splenic arteries, with the aorta. The great usefulness
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of this gland may appear from its being found not only in man, but almost in all animals; nor is its use the less from that experiment, which shows a great part of it may be cut out from a brute animal, unattended with fatality; for, by that rule, the animal, surviving after a part of the lungs are cut out, would render them equally useless, and besides, in the experiment, a part of the pancreas must be left with the duodenum. As to this juice making any effervescence with that of the bile, the notion has been so long exploded, as to need no further notice.

LECTURE XXIX.

Of the small Intestines.

§ 700. **B**Y the small intestines, anatomists understand one continued, almost equal or cylindrical tube, whose transverse section is nearly oval; the acute end being towards the unconnected side of the intestine. This tube is continued from the end of the stomach, which it embraces (§ 624.), through a long folded tract down to a much larger intestine, the colon. Anatomists have usually reckoned three small intestines, though nature has formed but one. However, the duodenum has generally pretty certain bounds, terminating with its end in that part of the abdomen, which is above the transverse mesocolon (§ 642.). But the small intestine which lies below this mesocolon, commonly called the *jejunum*, has no certain mark or boundary, to separate it from the lower portion, which is commonly called the *ilium*: although the former, abounding more with valves and blood-vessels, has, in general, a more florid appearance, and is furnished with a longer villi internally; and the ilium again, having fewer of those vascular ramifications, like little trees, abounds more with a sort of minute glandules; however, these differences insensibly disappear one in another, without affording any certain limits betwixt the two intestines.

§ 701. The duodenum seems to be denominated from its length, measured by the breadth of the fingers. It is larger, and more lax or open than the other small intestines, more especially in its first flexures; which is partly owing to its not being circumscribed in some places with any external membrane, and in other places only for a small compass. It is florid and tender, having its fleshy fibres, sometimes of a considerable thickness. Its origination begins round the ring-like valve at the mouth of the pylorus; from whence it is undulated or inflected, but in a transverse course, to the right downward in an empty stomach, under the gall-bladder, to the neck of which it is contiguous (§ 691.). From the gall-bladder, it descends obliquely to the right side as far as the lower plate of the mesocolon, where it is perforated by the biliary duct (§ 698), and, in its course, is intercepted betwixt the upper and lower plate of the mesocolon, thro' which it proceeds, at length, transversely, but a little ascending behind the pancreas and large mesenteric vessels, and goes on to the left side along with the left renal vein, where, going out from the duplicature of the mesocolon, it bends round, before and to the right of the said vessels, and passes through a peculiar foramen, in which the mesentery and left part of the transverse mesocolon adhere to the intestine itself; from thence it descends forward, towards the lower part of the abdomen, into which it advances, under the denomination of the *jejunum*. The largeness of this intestine, with its ascent from

from the insertion of the biliary duct, joined with the consequent fold about the root of the mesentery, cause a remora of its contents, by which the bile, pancreatic juice, and alimentary pulp, are here first intimately blended together.

§ 702. The rest of the small intestine, having no certain seat or division, is continued by innumerable and uncertain convolutions, not to be described, so as to fill out the lower part of the abdomen and pelvis, surrounded by the colon on each side, and sustained by the bladder and uterus below.

§ 703. The fabric of the small intestine is almost the same with that of the stomach and œsophagus. Its external coat, excepting part of the duodenum, is received from the peritonæum or mesentery, applied on each side to the obtuse end of the oval intestine, and separated by the intervening cellular substance, which is often replenished with fat, but more closely embraces or adheres to the muscular fibres in the unconnected side of the intestine; where the outer and muscular coat strictly cohere, without shewing any remarkable difference from what we have observed of them in the stomach (§ 622.). By this external membrane. continued with the mesentery (§ 654.), the intestines are supported, with a considerable degree of firmness, at the same time that they are allowed every way a free liberty for motion.

§ 704. But the fabric of the muscular coat differs from that of the stomach, in the figure

of its fibres. The largest and most considerable body of these fibres are circular, cloathing the tube on each side, resembling each other, both in their parallel disposition and appearance, which is that of imperfect arches or segments of circles, cemented one to another, paler than other muscular fibres, and yet contractile with a considerable strength. The longitudinal fibres are, in the small intestines, much fewer in number, scattered round their whole extent, interspersed with the former, and are more especially spread upon the loose or unconnected side of the intestine.

§ 705. Within the muscular coat, is seated the second cellular, of a larger or looser extent here, as it was in the stomach; and this being spread on all sides round the nervous coat, which it includes, is, in us, seldom replenished with fat. But the nervous coat, being like that of the stomach, serves as an internal foundation or support to the whole intestinal tube; being composed chiefly of compacted fibres, which, by inflation, may be parted one from another, so as to resemble a web-like or cellular substance. Next to this, follows the third cellular coat, which is almost like the second; and then the innermost or villous coat, which differs, in several respects, from that of the stomach: for first it is folded on all sides into wrinkles, that are semicircular, the extremities of which correspond one to another oppositely, but uncertain in their proportions; into which wrinkles, the nervous coat enters in some degree, while the rest of the intermediate space, betwixt

betwixt the folds of the villous tunic, is filled up by the third cellular stratum. These plicæ or folds of the intestine begin within one inch of the pylorus, and are most frequent or numerous in the anterior or loose part of their middle tract, but grow fewer in number downward. Here each small twig of the artery, which is spread in the cellular substance, upon the convexity of the intestine on one side, is answered by another twig, disposed in the same manner, on the opposite side. The plicæ are, at first, confused in the duodenum, and afterwards become more conspicuous, as the intestine advances; but the appearance of acute imperfect circles or valves is given to them by anatomical artifice or preparation, in which their natural state is altered; for thus they are very soft, and easily fluctuate on all sides, so as to give way, in any direction, to the course of the alimentary pulp, upon which, however, their number has sufficient influence to retard the motion, while, at the same time, they considerably enlarge the extent of the absorbing villous coat.

§ 706. We come now to the true villous coat, which we call so in other parts, by analogy, from this, in which the fabric is most remarkable or conspicuous; namely, the whole internal surface of the intestine and its valves, together with the small cavities, interposed betwixt them, send out, on all sides, innumerable small fluctuating fleeces, like a piece of velvet or close frieze, the extremities of which are obtusely conical productions of the inner

coat of the intestine, formed by the intercepted cellular substance, in which small nerves and blood-vessels are wrapped together, so as very much to resemble the papillæ of the tongue, only of a softer texture.

§ 707. In the surface of this internal villous coat, open an infinite number of pores; some larger, others smaller. The former lead to small conspicuous simple glandules of the mucous kind, seated in the second cellular stratum, and like to those of the vascular follicles, seated in the mouth and pharynx, which likewise open with numerous patulent orifices into the intestines. In the duodenum these are assembled together in several places, without meeting one into the other, which they always observe; but many of them are quite solitary or asunder in the ilium, or often assembled only a few together, though, in many places, a considerable number of the same kind are assembled together, into a little army of an elliptical figure.

§ 708. Throughout the whole tract of the intestines, are found pores of a less kind, surrounding the basis of the villi, and most ample or conspicuous in the large intestines, where they were first observed; but have been lately discovered, by a more careful inquiry, in the small intestines likewise. These also seem to deposite a liquor of the mucous kind.

§ 709. The vessels of the small intestines are very numerous. The common larger trunk belonging to the intestine that occupies the space below the mesocolon, is called the mesenteric

teric artery, being the largest of those produced by the aorta above the renal arteries; and this, descending behind the pancreas to the right side of the jejunum, and before the colic branches, sends out more especially a long trunk to the bottom of the mesentery, and termination of the ilium towards the right side, as on the left side it sends out numerous branches, which, being longest in the middle, are continued shorter each way, like the sticks of a fan. These last, subdividing into smaller, form inosculation betwixt each other, in shape of an arch, which again send out other branches, repeated, in like manner, to about the fifth subdivision, where, forming their last convexity, their numerous small branches are detached on each side the intestine.

§ 710. The division of these branches is much after the same regular manner, so that one comes out from the mesentery, through the cellular substance, on the fore side of the intestine, as the other does, in the like manner, upon the lower side; and after spreading themselves upon the muscular coat, their smaller circling ramifications penetrate through into the second cellular stratum; there the anterior capillaries, advancing towards the outer apex or loose margin of the intestine, form inosculation directly with those of its opposite, gradually spreading and detaching smaller shrub-like twigs, inosculating with each other, and with their opposites, by innumerable circles. From this arterial net-work, smaller twigs penetrate, from the nervous tunic, into the third

cellular stratum, and are, with that, continued to the ultimate extremities of the villi, where they, at last, open by exhaling orifices, and discharge a watry humour into the intestine; for this continued course is easily imitated and shown, by injecting water, fish-glue, or mercury. But late industry has discovered, that these arterial extremities first open into an hollow vesicle; from whence their deposited juice flows out through one common orifice. For the rest, the arteries in this part, form numerous reticular inosculation, that, by avoiding all obstructions, they may be able to supply the intestines equally on all sides, and that any obstructing matter may, upon occasion, be easily removed back from the narrower extremities to the larger arterial trunks.

§ 711. The last mesenteric trunk or artery inosculates with the ilio-colic. The duodenum has various arteries. The first and uppermost to the right side goes round to the convexity of the inflexure of this intestine, which it supplies in its way to the pancreas, and inosculates together with the lower or left pancreatico-duodenal artery, which makes a like arch round the curvature of the duodenum into the pancreas, being, at last, inserted into the lower duodenal arteries, produced by the mesenteric, in its passage before this intestine. As to the small arteries, which go from the spermatics to the duodenum, and from those of the renal capsule, we designedly omit any further notice of them.

§ 712. The mesenteric veins meet all together, in the same course or disposition with the arteries, into the mesenteric trunk of the vena portarum, except the right duodenal vein, which goes immediately into the trunk of the vena portarum itself, and except those small veins, which run in company with the preceding small arteries (§ 611.), and are inserted into the spermatics and lumbals. Nor have I been able to discover any other veins of the mesentery, arising from the cava. It is a property, in common, to all these veins to be without valves, and to make free communications with the arteries. Those veins in the villous coat, which is, for the most part, composed of veins, absorb thin humours from the intestine, as appears from the injection of watry liquors, which readily run through the same way; and, from analogy, in aged persons, in whom the mesenteric glands, and consequently the lacteals that pass through them, are frequently closed up; add to this, that birds have no lacteal vessels, and the celerity with which watry liquors pass to the blood and through the kidneys, compared with the smallness of the thoracic duct, seem to make it evident, that a large part of them enters the blood immediately, by the mesenteric veins.

§ 713. The nerves of the mesentery, tho' small, are numerous, whence the intestines receive no little degree of sensibility; they arise from the middle plexus of the splenic nerves, and, embracing the mesenteric artery, play round it in great numbers, wrapped up in a very dense

dense cellular plate. The duodenum has likewise small nerves from the posterior hepatic plexus of the eighth pair.

§ 714. From the exhaling arteries distils a thin watry liquor into the cavity of the intestines, not at all acid, but like the juice of the stomach; the quantity of which liquor may be computed from the large extent or sum of all the excretory orifices, and from the section or light of the secretory artery, larger than which, we see no where in the body; add to this, the laxity of the parts, perpetually kept warm and moist, and the copious diarrhœa or watry discharge, that often follows the use of purgative medicines. But the mucus, arising from the pores or cells before mentioned (§ 707. and 708.), serves to lubricate and defend the internal surface of the villous membrane, and to guard the sensible nerves, from strongly acrid or pungent particles. Hence we see, it is more abundant at the beginning of the larger intestines, because there the mass of aliment begins to be more sæculent, acrid, and tenacious.

§ 715. The mixture of this liquor with the pulp-like mass of the aliment, together with the bile and pancreatic juice, is made by the motion of the surrounding muscles of the abdomen, but more especially by the *peristaltic motion*, which is more particularly strong and evident in the small intestines. For any part of the intestine, irritated by flatus or any sharp or rough body, contracts itself, even after death, with a considerable force, in that part where the

the stimulus is applied, in order to free itself from the offending or distending body, which it expels into the next open part of the lax intestine; where, being received, it is again propelled forward, by exciting a like stimulus and contraction as before. This contracting motion of the intestines is made in various parts of the gut, either successively or at the same time, wherever the flatus or aliment excite a stimulus; and this, without observing any certain order, with a sort of wonderful alternate creeping and revolution of the intestines, as appears easily from the dissection of living brutes, and sometimes by unhappy accidents in our own species, as in ruptures and wounds in the abdomen, &c. [This creeping of the guts, for facility and duration, is equal, if not superior, to the irritability of the heart itself, § 114.] And since here, among so many inflexions, the weight of the aliment is but of little force, it easily ascends or descends through the irritated intestine, which thus empties itself. From hence, the use of the peristaltic motion is intelligible, by which the pulp of the alimentary mass is oftener or longer applied with a gentle force to the triture of the intestine, to the exhaling diluent liquor, and to the mouths of the absorbing veins. But all the contents of the intestine are determined downward to the colon, because the stimulus begins above, from the left opening of the stomach; and so, by the succession of new chyle, repeating the stimulus above the contraction, it descends, when there is no resistance made to it, into the lower part
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of the ilium, at its opening into the colon; here the loose part of this intestine readily receives what is pressed into it by the contraction from above, and as easily unloads itself into the large unactive cæcum; from whence it is again repelled upward, and, in part, urged on by the pressure of the succeeding mass. Anatomists observe, that this motion is made stronger downward than upward.

§ 716. This peristaltic motion of the intestines is performed by the constriction of their circular fibres, which exactly know how to empty the tube, without injuring the intestine against pins, needles, or any other sharp bodies lodged within their contents, which they tenderly promote forward. But the revolutions of the intestines, drawn upward and downward, and the straightening of crooked parts of them one before another, which is so remarkably conspicuous in brute animals, are performed by the long fibres, which we see contract themselves at the seat of the present stimulus, and dilate the following portion of them, to receive what ensues. By the same contraction, the villous membrane of the intestines, within their cavity, is urged and reduced into longer folds; whence the mucus is expressed and applied to that part of the alimentary mass, where it was required by the force of irritation and stimulus. These long fibres frequently make intussusceptions of the intestines, and generally without any bad consequences, by drawing up the loose portion of the intestine into that which is contracted, in such a manner, that the loose
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portion is surrounded by the other, which is contracted.

§ 717. The alimentary pulp, therefore, diluted with the pancreatic juice and that of the intestines, intimately mixed with the saponaceous bile and circumjacent mucus, is so more perfectly dissolved than by the efficacy of the stomach, in proportion as the sides of the intestines come into a larger contact, and approach nearer together; to which add, the longer series of the peristaltic motions, and the greater quantity of dissolving juices. In this manner, the alimentary pulp, intermixed with air, forms a froth, without any kind of fermentation, which air is the same with what we commonly eructate from the stomach; but yet, at the same time, the acid or acescent force is subdued, while the oily or fat parts dissolve by the bile (§ 693.), intermix with the watry juices, and put on the chyme its usual milky appearance, like an emulsion, of a bright colour in the duodenum, at the first entrance of the biliary duct; from whence downward it closely adheres to the villous coat of the small intestines. But the gelatinous juices of flesh meats, diluted with a large portion of water, do more particularly adhere to the villous coat, and enter it in the way of absorption. So water and watry liquors are all very greedily drank up by the veins, and yet the fæculent remains never grow thick in the small intestines, as far as I have been able to observe; because the watry part is repaired by the arterial vapour and mucus; nor do they become foetid in any
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considerable degree, as well because of the great quantity of diluting juices, as because the quick progression will not allow them time enough for a putrefaction. Chyme is of a white colour in the beginning of the jejunum, but is altogether mucous in the end of the ilium. Those remains, which are of a more earthy, gross, and tough or acrid disposition, which were excluded by the mouths of the absorbing lacteal orifices, do, by their weight, or by the muscular contractions, descend slowly into the large intestines, so as to complete their whole course in the space of about twenty-four hours. But within three, four, five, or six hours time, all the chyle or lacteal juice of the aliment is commonly extracted from the small intestines.

§ 718. The considerable length of the small intestine, which is five or more times longer than that of the body, the great surface of the villous membrane increased by folds, the incredible number of exhaling or absorbing vessels, the slow course of what remains through the large intestines, and the great quantity of the intestinal juice, poured into the alimentary mass, do all of them concur, in the small intestine, abundantly to perform what is required in the emulsions of the food for our healthy juices, and for their absorption into the lacteals and the mesenteric veins; also for absterfion of viscidities from the intestine, for the avoiding adhesions and coagulations, and for the subduing any venomous or strong quality in many juices, which, being directly mixed with the blood,

blood, instantly kill, but are thus sent in by the mouth without damage. Hence, in general, the intestines are long in animals, that feed upon any hard diet, but shorter in carnivorous ones, and shortest in all those that live upon juices; and, even in man, an uncommon shortness of the intestines has been known to be attended with hungryness, and a flux, or a discharge of foetid and fluid fæces.

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LECTURE XXX.

Of the chyliferous Vessels.

§ 719. **T**HE chyle is a white oily juice, extracted from the aliments (§ 717.), which is afterwards poured into the blood. That its principal composition is of water and oil, seems evident, from the sweetness of its taste, from the whiteness of its colour, and from its spontaneous acedent nature; in all which it resembles an emulsion. It seems to be composed of a vegetable farina, with animal lymph and oil; whence, with a little alteration, it changes into milk. But afterwards it becomes more manifestly glutinous; since the pellucid serum it contains, either by exhaling the watry part, or by applying an intense heat, coagulates into a kind of hard jelly, less firm than an egg.

§ 720. That the chyle is absorbed into the lacteal vessels, by the adhering villous coat, has been a long time known, by experiments of injecting tinctured liquors, which readily describe the same course; and from the white liquor of the lacteals, let out from blood-vessels, with the venal nature of them. But late experiments have taught us this, in a much better manner. The chyle is absorbed by a small opening in the extremity of each of the villi, by the same force which is common to all capillary tubes, by which it is taken up into the cavity of the absorbing

sorbing duct, at the time when the intestine is relaxed; but the vesicle, by which the absorbing duct begins in the intestine, being pressed by the succeeding constriction of the muscular fibres in the peristaltic motion, urges the contents further on into the duct, which begins to appear within the second cellular stratum. But there is a two-fold stratum of these absorbing vessels, one anterior, the other posterior, as we observed before of the blood-vessels (§ 709). From thence, uniting into a larger canal in the first cellular stratum, the absorbed liquor enters into the lacteal vessels, which, in general, follow the course of the arteries, only loose, and without circles or arches, but conjoined into an obliquely angled net-work. They are furnished with valves, as soon as ever they are passed the intestine, like those of the lymphatics, joined together by pairs, of a semilunar figure (§ 52.), which admit the chyle, passing from the intestines, but prevent its return, and sustain its weight. Through this whole course, the chyle is urged on by the peristaltic motion of the intestines, as well as by the contractile force of the vessels themselves, which, even after death, is strong enough to propel the chyle; to which add, the considerable pressure of the abdominal muscles and other parts, determined by the valves. The greatest number of these lacteals arise from the fore-part of the small intestine, below the mesocolon, some from the duodenum, and a few from the large intestines themselves.

§ 721. But betwixt the plates of the mesentery, at the divisions of the vessels, are found an infinite number of small conglobate glandules (§ 182.), but somewhat softer and more spongy, owing to a greater turgescence with cellular juices, also from the external membrane being less hard than in other parts, and from their being painted with numberless small blood-vessels. Into one of these glandules, enters a lacteal vessel, where, subdividing into branches, it pours out the chyle into the cellular fabric of the gland; from thence again it is pressed by the contraction of the vessels, but more especially that of the abdominal muscles, by which the chymous emulsion, entering the lacteal vessel, is drove on successively to two or three other glands of the like kind, and passes by others, in the way, without entering into them. But that this is the true course of the chyle, by which it passes from the intestines to the mesenteric glands, appears from a ligature by the vessel, growing turgid betwixt the said ligature and the intestine; and from schirrhosities in the glands, by which they are rendered more conspicuous; and from the nature of the valves themselves hindering any return back to the intestines.

§ 722. What alteration the chyle undergoes within the cellular fabric of these glands, is not yet sufficiently known; but it appears, in general, that some thin liquor distils from the arteries in this part, serving to dilute the chyle, into which it is poured. For it is observed, that after the chyle has surmounted all the glands,

glands, it appears more watry; and thin liquors, injected through the arteries, pass out into the cellular fabric of the glands, and mix with the chyle.

§ 723. From the last glandules, which are collected together in the center of the mesentery, the lacteal vessels go out very large, and few, to the number of four, five, or more, which ascend together with the mesenteric artery, and intermix with the lymphatic plexus, that ascends from all the lower parts of the body, creeps over the renal vein, and then goes, with this and the hepatics, behind the aorta, to the lumbal glandules. Here the lymphatics take a variable course, but most frequently terminate in a vesicle of considerable breadth, at the side of the aorta, betwixt that and the right appendix of the diaphragm; there it usually appears somewhat turgid, two or more inches long, and often ascends above the diaphragm into the thorax, conical both above and below; 'tis called the receptacle of the chyle, in which the gelatinous lymph of the lower limbs, and of the abdominal viscera, mixes with the chyle, and dilutes its white colour. But there are some instances, where there are only two or three small, and somewhat angular ducts, instead of this receptacle or cistern of the chyle; which, however, generally speaking, is to be found in most subjects, and suffers a considerable alternate pressure from the diaphragm and aorta, by which the chyle is moved faster through it, in proportion, as the light of the cistern is

greater than that of the thoracic duct, into which it empties itself.

§ 724. The thoracic duct, as it is called from its course, is generally single, or, if it be double for some part of its course, it soon after unites into one again, which goes behind the pleura, betwixt the vena azygos and the aorta; and, ascending in an inflected course, it receives, in its way, the lymphatic vessels of the stomach, œsophagus, and lungs, and passes through the dorsal glands, of which there are many incumbent on and about it. It is, in general, cylindrical, and often forms insulations, by splitting or dividing into two or more; after which it unites into one again, more especially in its upper part. It has few valves, and those not very conspicuous. About the fifth vertebra of the back, it generally crosses behind the œsophagus, and then ascends along the right side of the thorax, behind the subclavian blood-vessels, 'till it has arrived near the sixth vertebra of the neck.

§ 725. There, bending down, it often divides into two, and each descending branch dilates into a sort of vesicle that enters, either with distinct or united openings, into the juncture of the subclavian and jugular vein internally, by an oblique course from the upper, posterior, and lateral part downward towards the left, and forward, going either with one or with two branches under the subclavian, on the outer side of its juncture with the jugular. It has no true valve placed before it; but excludes the entrance of the blood, only by the perpendicular

cular weight of its contents. But the oblique insertion of it represents a sort of wrinkle. It is rarely otherwise disposed, and more rarely split into two, length-wise, for distinct insertions into the subclavian; and yet more rarely apt to send off a branch into the vena azygos. Near its insertion it receives the opening of a large lymphatic vessel, transversely from the arm, and another descending from the head, in one or more trunks.

§ 726. The chyle, mixed with the blood, does not immediately change its nature; as we learn from the milk, which is afterwards made of it. But after five, or more hours have passed from the meal, almost to the twelfth hour, during all which space, a woman will afford milk; after it has circulated near 80,000 times through the body, fomented with heat, and mixed with a variety of animal juices, it is, at length, so changed, that a part of it is deposited into the cellular substance, under the denomination of fat; a part of it is again configured into the red blood-globules (§ 165.); another part, that is of a mucous or gelatinous nature, changes into serum; and the watry parts go off, in some measure, by urine, in some measure exhaled by perspiration, while a small part is retained in the habit, to dilute the blood. Nor is it any thing uncommon for a pellucid lymphatic liquor to fill the lacteals, in a dying animal, instead of chyle; or for some of them to appear milky in one part of the mesentery, and limpid or pellucid in another: since, both as to their fabric and use, they also agree to answer

the end of lymphatics. There are not, therefore, two kinds of vessels from the intestines; one to carry the chyle only, and another peculiarly for the conveyance of lymph.

§ 727. After the digestion has been completed some time, the lacteal vessels absorb pellucid watry juices from the intestines, whence they appear themselves diaphanous; but the thoracic duct is more especially a lymphatic of the largest order, conveying all the lymph of the abdomen, lower extremities, and most parts of the body to the blood (§ 51).

LECTURE XXXI.

Of the large Intestines.

§ 728. **W**HAT remains, after the chyle has been abstracted, consists of some portion of the bile and intestinal mucus, but both depraved in their nature; some part of the human mucilages, most of the earthy parts that were lodged in the food, and all those parts, which, by their acrimony, were rejected by the absorbing mouths of the lacteals (§ 717.), with all the solid fibres and membranes, whose cohesion was too great to be overcome by the maceration and peristaltic motion in the intestines.

§ 729. All these remains pass from the extremity of the ilium into the cæcum, in which they are collected and stagnate; namely, the extremity of the small intestine, called the ilium, applies itself obliquely, in such a manner, to the right side of the colon, resting upon the right ilium and its muscle, that, in general, it ascends in a curve, but more in its lower side, and less in its upper, which is almost transverse. But finally, the nervous and villous parts of the ilium are so extended, betwixt the departing fibres of the muscular and nervous coat of the colon, as to hang pendulous within the cavity of this large intestine, with a double eminent wrinkle or soft fold, composed of the villous and nervous coat of

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the thick intestine, and of the small intestine likewise, joined together by a good deal of the cellular substance. The upper transverse fold is shorter, as the lower is broader and more ascending, being conjoined together by a small production of the same kind, more especially in the right side, adjacent to them. Betwixt these two folds, the mouth of the ilium opens, like a transverse slit. But when this intestine is inflated and dried, the structure of it changes very much, representing these parts to us, under the figure of membranes and hard valves. After the cellular plate has been entirely removed from them, the ilium comes clean out from the colon, and the valvular appearance is no more to be seen; but if a large part of it only be drawn out, leaving a small portion inserted behind, it resembles a sphincter.

§ 730. Below the entrance of the ilium, at the distance of some inches, the great intestine descends and forms a blind or impervious extremity, called the *cæcum*, resting upon the ilium. From the lower part of this, towards the right side, extends a small worm-like process, in adults of considerable length, like a longly extended cone or little intestine, variously incurvated, sometimes downward, and full of small mucous glands, which pour out a gluey mucilage to the *fæces*; but, in the *fœtus*, the colon itself is extended into a conical appendix. But the weight of the superincumbent *fæces*, depressing the space on the right side of the appendix, is the cause of its gradually receding from the extremity of the colon. When, there-

therefore, the remains of the alimentary mass are sent from the ilium into the colon, they fall by their weight first into the cavity of the cæcum, or impervious bag-like appendix; here, by stagnating, and the warmth of the parts, they begin to putrify, according to their particular nature; and thus is introduced the foetid smell, observable in the excrements.

§ 731. The colon is an intestine altogether continuous, as one and the same with the former cæcum; namely, the largest of the great intestines, and by much the strongest: beginning upon the ilium (§ 729.), it ascends over the right kidney, and lies under the liver, with an angle in the right hypochondrium; being connected to the viscera, on each side, by the peritonæum. From thence it passes under the liver and stomach, for the most part, transversely to the spleen, under which it is bent in such a manner, as often to form an angle with itself; from whence it descends deeply under the left ribs (§ 660.). From thence again, continuing its descent to the left ilium, it forms a large flexure inwardly to the pelvis (§ 641.); from which flexure it is continued, in its lower part, through the pelvis, under the denomination of rectum.

§ 732. The structure of the colon is in general the same with that of the small intestines, but it has several things peculiarly differing from them: and first, the longitudinal fibres are collected together into three bundles or tapes, commonly called ligaments, which run through the whole extent of the intestine; and

of these one lies naked, the other is covered by the omentum; and the third is contained in the mesocolon. These ligaments, which adhere first to the dilation of the vermiform appendix, being much shorter than the intestine, the latter is by their cohesion drawn together so as to form its membranes into protuberant wrinkles in the parts which lie betwixt the ligaments; more especially at the mesocolon is seated the first cellular stratum, replenished with fat. There are often only two ligaments in the extremity of the colon, where the two lesser join into one.

§ 733. Again, the nervous coat, and third cellular stratum, with the villous tunic of the colon, are extended into much larger wrinkles, in the parts betwixt the ligaments, often projecting in a three-fold rank, sustained by the ligaments, that they may be able to resist and support any shock or pressure from the motion of the fæces. In the beginning of the colon, they observe their three-fold order, exactly enough, at regular distances; but in their progress they vary more by degrees, being less, sometimes double, often solitary, small and large intermixed, or none at all. Where the ligaments which contract the colon disappear, these valves almost disappear entirely. Lastly, the villous coat is thinner, without villi, but porous and wrinkled, furnished as well with large peculiar pores of its own, leading to round follicles or cells, which are solitary as well as innumerable small pores, leading to smaller follicles, both which supply a great quantity of mucus.

§ 734. The blood-veffels of the large intestines, from the mesenterics, are of two kinds. First, the middle colic artery arises from the large mesenteric trunk, as that descends behind the transverse mesocolon, where it arises up with one, two, and sometimes three branches, going to the right side with the ilio-colic, and to the left, where, with the lower mesenteric, it meets it in a very large arch, which makes the most considerable arterial inosculation in the whole body. Again, under the mesocolon, from the same large mesenteric artery, arises a considerable branch that goes directly to the fold of the ilium with the colon, and upward to the right colon; but to the left it runs together with the mesenteric, out of the middle of which it gives a branch that runs along the worm-like appendix of the mesocolon, and terminates itself in both the anterior and posterior fold, by which the ilium is inserted into the colon. Lastly, the lower mesenteric, arising by its proper trunk from the aorta, betwixt its bifurcation and the renal arteries, goes to the left colon: above, it runs by a large arch, together with the middle colic, and being bent downward in three or four trunks, it spreads over the flexure of the colon, and descends even into the rectum. Finally, the lower mesenteric, goes out by a proper trunk from the aorta, betwixt its bifurcation, above the os sacrum and the renal arteries, whence it is distributed to the left colon; but it runs up by a large arch with the middle colic, and bending down in three or four trunks, spreads over the iliac flexure of
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of the colon, and descends even into the rectum. Here the rectum receives various branches from the middle hemorrhoidal, arising from the last trunk of the hypogastrics, and conjoined with the former. The ultimate arteries are from the same trunk, but distributed without the pelvis. We neglect here the smaller colics, arising from the spermatics, intercostal, omental, capsulary, and lumbal arteries. The veins, taking the same course with the arteries, run together into the gastrocolic, and the hemorrhoidal, which last is either internal, middle, or external.

§ 735. The division of the vessels to the large intestines, differs from that of the small intestines. The arches the trunks send off are neither so frequent nor so often subdivided; they run further entire upon the intestinal tube, accompanied with fewer glands, and their branches are distributed not so much like trees, and form fewer net-works in the cellular substance; but they distil an exhaling moisture into the cavity of the intestines, as the veins likewise absorb a thin foetid vapour from the faeces.

§ 736. But there are also lymphatic vessels, arising from the whole tract of the colon and rectum, which conjoin with those of the loins. We are not without examples of the chyle entering these lymphatics from the colon, instead of lymph, which is an argument that they are of some further use in this part, by conveying nourishment to the blood. From hence is the efficacy of nourishing glysters, and those used in fevers,

fevers, which pass by these into the blood, often very readily.

§ 737. The nerves of the large intestines are from the plexus, composed by the descending branches of each renal plexus, and others arising from the intercostal trunk of the thorax and loins, with others produced from the large mesenteric plexus. These nerves accompany the lower mesenteric artery, and pass with them to the colon. The lowermost nerves arise from the left colic plexus, before mentioned, from whence they go to the rectum, within the pelvis; others are from the lower intercostals, and the nerves of the sacrum, which terminate likewise in the rectum. These nerves are of the smaller kind, which renders the intestine less sensible, that it might better sustain the pressure of the hard and acrid fæces.

§ 738. The intestinal fæces, therefore, retained in the blind beginning of the colon or large intestine (§ 729.), there grow dry by the absorption of moist vapours, so as to be capable of receiving a figure from the round contracted parts of the colon, by which being sustained as on a stair-case, they ascend from the bottom of the cæcum, elevated by the long ligaments, which end in the worm-like appendix. And here we are more easily capable of perceiving the manner, in which the fæces are propelled, by the muscular contractions of the round fibres, whose contractions are less conspicuous in the small intestines. The longitudinal fibres of the intestine, being attached to the contracted parts as fixed points, draw up and dilate

dilate the lower parts of the intestine; then the next parts of the intestine, to which the fæces are brought, being irritated and contracted in like manner, are immediately after drawn together by the round and long fibres, by a successive repetition of which the fæces finish their course entirely, through the whole large intestine: for wounds in mankind, and the comparative anatomy of brute animals, demonstrate this peristaltic motion of the intestines to the eye, which is also confirmed by the antiperistaltic motion, and its consequences or appearances, by which the matter of glysters is returned up through the mouth. But these proper actions of the intestines themselves, may be in a good measure promoted by a contraction of the muscles of the abdomen.

§ 739. While the gross or thick fæces of the intestines ascend by the folds (§ 729.) or valve of the ilium; the weight of them depress the lower fold to the left side, which draws back the ligament common to each valve, in such a manner as to compress and exactly close or shut the upper fold downward, that nothing may return back into the ilium, which might easily happen in a fluid state of the fæces, if this port was not so accurately shut up. From thence they continue to move slowly forward, more dry, consistent, and figured by the same causes (§ 738.) through the whole tract and repeated flexures of the colon, which is sometimes of five or seven feet in length, so as to retain the fæces a space of time sufficient to give no interruption to the affairs of human life;

life; which time is less in proportion than twenty four hours, as the small intestines retain their contents a shorter interval of the same space.

§ 740. At length the figured excrement falls into the *rectum*, which is inflected first a little downward, and then forward, of a broad depressed figure, at first descending contiguous to, and afterwards spread under the bladder, or vagina, but connected more with the former than the latter. Here, for a great while, and often to a great quantity, the *fæces* are collected together, in a part which is loose, or openly surrounded with soft viscera and muscles, with a good deal of fat.

§ 741. The structure of the rectum differs very much from that of the other intestines. The external membrane or peritonæum is only spread before it, while behind it is supported by a broad stratum of the cellular substance, replenished with fat, and many conglobate glands, connecting this intestine all the way to the os sacrum. The muscular fibres, in this intestine are much stronger and more numerous, more especially the longitudinal ones, than in the other intestines; being composed of the three ligaments of the colon, expanded and separated, first over the anterior face, and then over the whole intestine; which they dilate against the advancing *fæces*, and draw back the intestine, after it has excluded them. But the transverse fibres are also strong, and the last of them are oval, forming a protuberant ring, which

which is the internal sphincter itself, by which the opening of the anus is closed.

§ 742. Moreover, the villous tunic, extremely full of pores, of a tender substance, and rough surface, full of reticulated soft protuberances and wrinkles, has likewise some sinuses. Namely, that part of the intestine which is next to the skin or outward opening, forms a white firm circle like a valve, into which descend the longitudinal folds, but incurvated and approaching one to another in the circle itself. Betwixt those folds, are intercepted sinuses, hollow upwards, and of a greater depth towards the lower extremity of the intestine. Into the cavity of these open the mouths of the large mucus glandules; while the margin of the anus itself is defended by sebaceous glandules, that it might not be excoriated with the harder acrid fæces.

§ 743. There are also proper muscles which govern the anus. Of these the outermost is the *sphincter*, which is broad and fleshy, consisting of two plates of half-elliptic fibres, which cross each other towards the coccyx, and towards the genital parts. To the former of which, the fleshy bundles degenerating into a callous fabric, descend, and are inserted into the coccyx: but forward, they are firmly attached by dense portions of the same kind, into the skin of the perinæum; but by three stronger portions in the middle, and two in the sides, they are inserted into the bulb of the urethra, whose lateral parts they surround, betwixt the sphincter and levator. The fibres, therefore, of the sphincter, placed betwixt the anterior and posterior face of the rectum,

rectum, ascending in a direct course, close the opening of the anus, which they surround. With the internal sphincter, the external one is conjoined by fleshy portions, that they may co-operate together. The constriction of them is not perpetual but voluntary: for the anus seems to close itself naturally, if the smallness of its opening be compared with the largeness of the intestine above, and with the corresponding wrinkles (§ 741.), aided by the strength of the transverse fibres of the internal sphincter, and the incumbent bladder.

§ 744. But there is another office belonging to the levators, which are broad complicated muscles; they descend broadly from betwixt the opposite protuberances of the ossa ischia, placed under the rectum and bladder; and serve to sustain the rectum on each side, and prevent it from subsiding, or from an unsightly eversion. Moreover the same fibres of the levator, declining broadly from each other, in the nature of a sphincter, to which they join, serve to dilate its orbicular fibres, and open the anus; but at the same time they both elevate and sustain the intestine from prolapsing downward, by the pressure of the hard fæces. They arise, as is well known, from the spine of the ischium and synchondrosis of the ossa pubis, terminated by the margin of the great foramen of the pubis, and that part of the ischium, which is above the tubercle. Finally, they meet together in one above the coccyx, into which they are inserted by numerous fibres.

§ 745. Therefore, whenever the fæces are collected to some quantity, within the rectum, so as to be troublesome, by their weight, irritation, or acrimony, they excite an uneasiness thro' the adjacent viscera, and are then urged downward, by a voluntary pressure through the straits of the collapsed intestine (§ 743.) by the force of the incumbent diaphragm; for by this the viscera of the abdomen, which is always full, are determined downward, through the inner rim of the pelvis, so as to urge upon the contents of the less resisting bladder and rectum. When the resistance of the anus is thus overcome, the compressing forces of the diaphragm abate, and the fæces continue to discharge from the body, urged only by the peristaltic motion itself of the intestine. After the fæces are expelled, the intestine is drawn back or up into the body, by its longitudinal fibres; after which the opening of the anus itself is closely contracted by the two proper sphincters, as at first.

LECTURE XXXII.

Of the Kidneys, Bladder, and Urine.

746. **T**HE chyle (§ 719.) which is taken into the blood, contains a good deal of water; the proportion of which would be too great in the vessels, so as to pass into the cellular substance, if it was not expelled again from the body. Therefore a part of this is exhaled through the skin (§ 438.); and another part, as large, or often more than the former, distils through the kidneys to the bladder, from whence it is expelled out of the body.

§ 747. These kidneys are two viscera, placed on each side the spine of the back, behind the peritonæum, incumbent upon the diaphragm, and upon the psoas and quadratus muscles of the loins; but in such a manner, that the right kidney is commonly placed lower and more backward than the left. Before the right kidney is placed the liver, upon its upper part (§ 670.) and then the colon covers the rest of its anterior face; and the left kidney is also covered by the spleen, stomach, part of the pancreas and the colon. They are tied by ligaments or reduplications, formed of the peritonæum to the colon, duodenum, liver and spleen. Their figure is externally convex, with a semielliptic deficiency in their inner side; laterally they are flat or depressed, inwardly hollow, unequally divided into one upper, or longer and thicker
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plain, and lower, slenderer extremity. They are firmly invested by a strong external membrane, which is dense, and adheres very closely. Betwixt that membrane and the peritonæum of the loins, there is always interposed a considerable quantity of fat, by which the whole surface of the kidney is surrounded on all sides, as with a shell.

§ 748. The blood-vessels of the kidneys are very large, as well the arteries, which together exceed the mesenteric, as the veins. And first, the renal arteries pass out from the aorta under that of the mesentery, not always in the same manner, yet so that the left is commonly shorter than the right, and each of them, frequently in two, three, or four distinct trunks. From those trunks arise the renal arteries of the lower sort, with the adipose ones belonging to the fat cortex, or capsule of the kidney (§ 747.); and not unfrequently they give origin to the spermatics. The smaller branches which they receive, are from the spermatics, and arteries of the loins, which supply them with fat.

§ 749. The renal veins are very large, more especially the left, and more inconstant in their course than the arteries; for the right is often without a branch, short and concealed, while the left always generates the spermatic and capsular vein of the same side, and almost constantly receives the last branch of the vena azygos; and being of a considerable breadth, it extends a long way transversely before the aorta, with the duodenum incumbent upon it. Both the arteries and veins of the kidneys arise from
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the great trunks laterally, a little descending in an obtuse angle; and divide themselves into many branches, a little before they enter the kidney. That the passage of the blood through the renal arteries into the veins is very expeditious, readily appears from the easy course that is afforded to water, wax, or even air injected. There are lymphatic veins considerably large, found about the renal blood-vessels, which give origin to the cistern of the chyle, or roots of the thoracic duct (§ 723.), which are said to receive the dispersed branches that are spread under the cellular coat of the kidney.

§ 750. The nerves of the kidneys are small, but numerous; arising from a considerable plexus, communicating on each side by ganglions or knots, which are generated by the branches of the great semilunar ganglion, conjoined with others from the intercostal trunk, creeping along from the thorax itself; they enter the kidney, together with the artery, and send off the middle mesenteric (§ 737.) and likewise the spermatic nerves. As these nerves are small, they afford but a moderate degree of sensibility to the kidney; and as they wind about the renal artery, like a plexus, we may thence understand how passions of the mind suddenly increase the renal discharge to an excessive quantity; so that the urine, which was before thick, and little in quantity, is by a nervous spasm expelled, of a watery consistence, and in excessive great quantities.

§ 751. Upon the top of each kidney is seated the renal capsule or glandule, of the conglome-

rate kind, triangular, and connected by each of its sides to the liver, spleen, pancreas, diaphragm, and kidney; inwardly it is hollow, parted by a sort of separable ventricle, full of a liquor of a yellowish red colour, and of a fluid consistence, almost like blood; and in the foetus, the bulk of this gland exceeds that of the kidney itself, but does not afterwards grow larger in the adult. The arteries of these capsules are many, chiefly of three kinds; the uppermost from the phrenics, the middle one from the aorta, and the lower ones from the renals; but the veins are only a large one on each side, that of the right to the cava, and the left to the renal vein of the same side. The said vein creeps almost naked, in branches, through the tender ventricle, in a sulcus, dividing the capsule. The uses of this gland are as yet unknown; although we are led to believe, from the situation, that it is subservient to the kidney, and of greater use to the foetus; since it is constantly found near the kidneys, and in so many different animals. The fabric of it approaches very near to that of the thymus; but it has no visible excretory duct, nor does it discharge any juice, by visible pores, into the vein.

§ 752. The internal fabric of the kidney is simple enough, and sufficiently known. The blood-vessels having entered the interval, betwixt the upper and lower stratum of the kidney, spread into its substance, surrounded with the cellular web, and divide into branches betwixt those of the pelvis; beyond this they go out to the cortex, and frequently form inosculations,

culations, in going betwixt every two branches of the pelvis, whence their circles are extended round the papillæ. From thence outward they are continued into and amongst the papillæ, by innumerable small tendrils, which lead towards the external surface of the kidney (and sometimes, passing through the proper coat of the kidney itself, enter into its adipose covering) where being changed into minute serpentine curls, reflected again towards the trunk of the artery, from whence they rose; thus they form a boundary to the kidney, and are then gradually stretched out into direct slender ducts or tubes, which visibly receive and deposite the urine from the artery. The secretion which is made from this artery, may be imitated without difficulty; by an injection with wax, water, or air, which will pass from the arteries of the kidney into the ureters. But such experiments do not succeed in parts that have small glands interposed betwixt their ultimate arteries and incipient veins. Betwixt these small uriferous ducts or tubes run many parallel arteries.

§ 753. Those uriferous ducts gradually converging towards the middle of the kidney, are collected together in small bundles, which, near the cavity of the kidney, form round papillæ, with their convexity full of pores; namely, the ultimate distilling orifices of the ducts, which secrete and deposite the urine into the pelvis. The number of these papillæ is not altogether certain, but there are thirteen or more of them; and these were in the foetus so distinct, that the kidney then appeared to consist of so many

distinct or smaller kidneys, as there are of these papillæ, connected together by a loose cellular membrane, betwixt each renal portion; and furnished every one with its proper cortex of serpentine vessels, from whence proceed the uriniferous ducts, assembled together in a direct bundle. But in adults, the cellular substance being condensed, unites the renal portions and their papillæ into one even kidney; however, it again almost recovers the condition which it had in the foetus, if the intervening cellular plates are relaxed by often injecting of water. The kidney is also remarkably larger in the foetus than in the adult.

§ 754. Round the protuberant surface of the said papillæ, is extended a loose membranous covering, in such a manner, distinct from the papillæ itself, as to form a larger space, like a tube or funnel, for receiving the papillæ into its cavity, projecting down from its upper margin, to which the tube adheres. Two or three of these tubes meet together in one, and with others of the same kind, they at last form by that union three hollow trunks, which again unite and open, but without the kidney, into one conical canal, called the pelvis.

§ 755. The blood of the renal artery being less fluid than that of the brain, and probably stored with more water, brought by the serpentine circles of the arteries, deposits the watry parts into those rectilineal tubes of the papillæ; a great portion of which water contains oils and salts, intermixed with earthy particles, or such other matters as are small enough

to pass through with it. But the small diameter of each uriniferous duct itself, at its origin, and its firm resistance, seem to exclude the milk or chyle, and the thick or oily and lymphatic parts of the blood, which are capable of hardening by heat. Hence therefore it is, that the blood passes so easily through the open uriniferous tubes, whenever it is urged with an increased celerity; or that by a morbid relaxation, they transmit not only the oily parts of the blood, but even the milk and nutritious juices themselves. The urine by fire or putrefaction soon changes into a volatile alkaline nature, intermixed with a fetid oil, partly empyreumatic, yellow, and volatile, and in part very tenacious, to be separated only by the last degrees of fire, under the denomination of phosphorus; and lastly, it abounds more with earth than any other juice of the human body. [But there is also a considerable proportion of sea-salt residing in fresh urine, from which it is even separable, after a long putrefaction, in the making of phosphorus; in which process a very great part of the urine is changed into volatile alkali. Nor is the urine wholly destitute of a vitriolic acid, or at least one much akin to it; both in that taken from men, as well as in the stale of cattle. There is again, a sort of fusible, neutro-alkalescent salt, separable in the urine, and easily melting by heat. In fevers, the oily and saline parts of the urine are greatly augmented, together with acrimony; as we know by its increased weight, colour, and tenacity.]

§ 756. The *ureter* being a continuation of the pelvis, carries on the urine received from the kidney, by pressure from the incumbent viscera, the contraction of the abdominal muscles, with those of the loins, and the force of the circulation urging the blood behind the secreted fluid. First, the ureter, covered by the peritonæum and cellular membrane, has likewise a thin muscular coat; a second cellular one; a firm, white, nervous coat; a third cellular one, lined with the innermost, which is of a smooth membranous fabric, porous and glandular, internally. These tubes are of different diameters in different places. They descend over the psoas muscles, cross over the great iliac blood-vessels into the pelvis, go behind the urinary bladder; and in the conjunction of the descending and transverse portions of the bladder, they enter obliquely, betwixt the muscular fibres and nervous coat; and so again, betwixt the nervous and villous coat, through which last they open by an orifice obliquely cut off; but they have no valves, neither at their opening in the bladder, nor in any part of their course. From their oblique insertion into the bladder, a protuberant line is formed, by the greater thickness of the nervous coat, which descends to the caput galliginis.

§ 757. Nor does there seem to be any other way for the urine to pass thro' the bladder, than by the kidneys and ureters; for altho' it is certain, that the stomach, like all other membranes, exhales a moisture thro' its coats, and though it is not improbable, from experiments, that the bladder

bladder also absorbs; and although the passage of mineral spaw waters, by urine, be extremely quick, yet it does not thence follow, that there must be ways, different from that of the ureters, to convey the water from the food to the bladder. For the bladder is, on all sides, separated from the cavity of the abdomen by the peritonæum; nor is it very likely, that the vapours, which either go out from the bladder, or which are derived towards it from other parts, can here find open pores through the peritonæum; nor do membranes imbibe much that have been macerated for any time, so as to fill their pores with humours; and a careful attention to the manner, in which mineral waters are discharged by urine, sufficiently demonstrate, that there is no such rapidity therein, as is commonly imagined; but the stimulus of the cold water drank, does, like the external cold, applied to the skin, cause a concussion of the bladder and urinary parts, by which they are solicited to repeated discharges of the old urine, which was before in the body, and not immediately of that which was last drank. Again, the largeness of the renal vessels demonstrates, that not much less than an eighth part of the blood sent to the body is received at a time, and consequently there are above 1000 ounces of blood conveyed through the kidneys in an hour; whence it will appear, but a moderate allowance, for 25 ounces of water to distil from that quantity of blood, driven thro' the kidneys in the same time. Finally, it is certain, that, both man and brute animals,

animals, perish, if the ureters are closed up by a ligature; for we then observe also, that no urine can be found in the bladder.

§ 758. The urinary bladder is seated in the cavity or bowl of the pelvis, which is an appendix to the abdomen, surrounded on all sides by bones; but laterally, and at the bottom, only inclosed by muscles. It is obliquely situated, so as to cohere with the os pubis by a large portion of cellular substance, by which it is connected to the peritonæum from thence backward, and for a small part of its surface before; but behind, it is extended to a greater length over the bladder, descending almost as far as the insertions of the ureters; from whence it returns back again, either over the rectum or uterus. Behind the bladder, lies the rectum, the seminal vesicles, and prostate gland, with the levatores ani. In the foetus, the bladder is very long, and somewhat conical, extending itself much above the ossa pubis; but in the adult, it hardly arises above those bones, even when inflated, because, in them, the pelvis is much larger and deeper in proportion.

§ 759. The figure of the bladder is, in general, oval, flatter before, more convex behind, terminated at bottom by a very obtuse or flat head, that lies incumbent upon the rectum. Such is the figure of it in an adult man, but, in the foetus, it is almost cylindrical, and in women, who have had many children, so much flattened laterally by pressure, that it resembles a sort of triangular cone. This change of the figure of the bladder in an adult man,
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from that of the foetus, seems to arise from the weight of the urine, gradually extending more the lower parts of the bladder, which are most pressed; by which means the sides are drawn together from above, so as to render it shorter and more concentrated.

§ 760. The fabric of the bladder is much like that of all large membranous receptacles. The first membrane is cellular, in its fore part lax, and replenished with fat; but backward it is thinner, where it unites with the rectum. Next to this, follows a muscular coat, very difficult to describe, consisting of pale contractile fibres, disposed in various reticulated bundles, not continued one to another, but interrupted with net-like spaces, in which the nervous coat lies uncovered. The principal stratum of these is longitudinal, which, arising before from the prostate, is frequently, though not always, so connected to the synchondrosis of the ossa pubis, as seemingly to arise from thence; thence, ascending and growing broad, they spread towards the conical part upon the upper side of the bladder, whose extremity they terminate; here passing on, they descend over the posterior surface, and grow there considerably broader, till, at length, they are finally terminated in the prostate. These must necessarily depress the bladder from before, and consequently propel the urine towards its bottom part.

§ 761. The remaining fibres are very difficultly reduced to any order. They fill the intervals of the former by arising from the prostate backward, and, ascending inflected, they form a
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transverse stratum of some depth, both in the forward and back part of the bladder. Over these are spread others, irregularly wandering from the longitudinal stripe, which going forward are related to the transverse.

§ 762. Within the muscular coat, is spread the second cellular stratum, of a tender elegant fabric, that may be inflated, and softer than that observed in the intestines. Next follows the nervous coat, as a continuation of the skin, and resembling the nervous coat of the stomach; over this is spread a more obscure villous coat, charged with mucus, and very difficultly separable from the former; but folded into various wrinkles, of an irregular or uncertain order. In the surface of this last, the pores of the mucous cryptæ sometimes appear conspicuous, but not always, without difficulty, pouring out a viscid soft glue.

§ 763. The vessels and nerves of the bladder are, in common with those which go to the genital parts, where we shall describe them. They form principally a net-work in the first or outer cellular stratum, and then another, in the second stratum of the same substance. The arteries exhale thro' the villous coat, as we learn, by experiment, from anatomical injections; and the veins likewise absorb again, to which is owing the greater consistence and higher colour of the urine, by a long retention of it. It has an accurate sensation, so as to render all liquors injected, even water itself, somewhat painful; and is disposed only to retain and be easy under the healthy urine. The lymphatic vessels,

sels, in the outer cellular stratum, are easily demonstrated; but their origin is from another part, probably from the adjacent rectum.

§ 764. Into this bladder the urine constantly flows, in a continued thread, as we are assured, from experience, in morbid and uncommon cases, in which the extremities of the ureters have appeared to the eye. By staying some time in the bladder, and from the absorption of the more watry part, the urine acquires an higher colour, becomes sharper and reddish-coloured; till, at length, by its bulk and acrimony, irritating the sensible fabric of the bladder, it is thence expelled, first by the motion of the diaphragm and abdominal muscles, by which the intestines are urged against the bladder, in a person who is erect and straining, whereby the urine makes itself away through a narrow and impeded course; and again, in this action, the peristaltic motion of the bladder itself, arising from the contraction of its muscular fabric (§ 761.), has a considerable share. Hence an ischuria follows from too great a dilatation of the bladder, by destroying the tone or elasticity of the muscular fibres.

§ 765. From the anterior margin of the obtuse or greater end of the bladder, called its bottom, goes out a slender canal with a small orifice, as a continuation of the bladder itself, under the denomination of the urethra; and in this, there is a manifest continuation of the cuticle of the internal coat of the bladder, with its surrounding cellular substance, and more especially a solid nervous coat, of which it is prin-

principally made up. This canal goes out forward, varying both in its direction and diameter, and, in a living man, its course is rather a little upward, obliquely ascending betwixt the departing crura of the ossa pubis; it afterwards ascends against part of their symphysis, and again, like an s, inclines downward; but it is shorter, more open and direct in women.

§ 766. This canal of the uretha is first surrounded, on all sides, by the prostate gland; from whence it goes out naked, for a small space, that is immediately continuous below, with the incipient bulb of the urethra, which likewise surrounds it on all sides above; but the cavernous bodies of the penis chiefly cover it above and laterally, so as to form a common groove for its reception, and add strength or firmness to this otherwise lax tube. It begins wide from the bladder, and contracts itself conically in the prostate, from which, being at liberty, it becomes cylindrical, and enlarges at the first accession of the bulb; from thence it goes on almost cylindrical, and again dilates itself a little before its termination.

§ 767. This canal is governed by various muscles, either proper to itself, or belonging to the parts adjacent. And first, in women, there are manifestly fibres placed round the egress of the incipient urethra, which are mostly transverse, but some variously decussating each other, whose office, and support in the vagina, manifestly appear; namely, to depress the urethra, like the sphincter, about the opening of which they are disposed, and, by this means, to close
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its opening against the resisting contracted vagina and sphincter of the anus. In man there are transverse fibres of the same kind, but forming an arch, that opens upward, they run into the conjunction of the bladder with the prostate, covering the longitudinal stripe (§ 761.), and prostate itself, near the bladder.

§ 768. But likewise the levator of the anus seems to raise the urethra against the os pubis, so as to close the opening of the bladder into it; and, in ourselves living, we may perceive the accelerator constricted, together with the sphincter, at the root of the penis, so as perfectly to close the opening of the urethra, and press back the urine, even while it is flowing; whence there is no room to doubt, but this muscle gives a moderate tightness for retaining the urine.

§ 769. These causes, with the weight of the urine, urging more upon the bottom of the bladder and against the rectum, rather than upon the opening of the urethra, which arises and ascends higher up, occasion the urine to be retained within the bladder, even in the dead subject, unless it be urged by the forces which compress the bladder. When the urine is evacuated (§ 764.) it runs forth with a greater celerity, in proportion as it comes through a canal smaller than the diameter of its large receptacle, and; being once discharged, frees the body from uneasy sensation. The last drops, which remain in the lower part of the bulb, irritating by their weight, are expelled by the accelerator muscle; namely, a strong muscular

expansion, placed round the bulb, whose fibres are disposed in the shape of a feather, meeting together in the middle of the bottom-part of the bulb, and in their fore-part fixed by two tendons into the cavernous bodies of the penis, and in their back-part connected by three muscular portions to the sphincter of the anus; two of which portions may be also referred to the levators of the anus. This muscle, when the sphincter is firmly shut, draws the bulb upward, and, with a considerable force, alternately contracts or shakes the urethra, so as to expel the last drops of the urine.

§ 770. But as the urine is sharp, and the membrane of the urethra very sensible, and because the air will likewise enter it; for these reasons nature has supplied this canal with a large quantity of mucus. This mucus is not only generated from the sources in the bladder, but more especially from two conglomerate glandules; one of which is seated on each side, in the angle, betwixt the bulb of the urethra and the cavernous body of the penis; from whence it sends out a slender duct, running, for a considerable length, through the urethra. Moreover, the whole urethra is full of mucous sinusses, of a cylindrical figure, which open or descend towards the glans, having small mucous cryptæ placed at their sides, which deposite there a fluid mucus, and discharge it into the urethra. A larger sort of these mucous cryptæ are disposed along the upper side of the urethra, beginning before the bulb, at the origin of the glans. There are others, still smaller,
mixed

mixed with these large ones, and placed laterally, and about the urethra. In women also there are many and larger of these mucous cisterns, which open into their much shorter urethra, more especially at its opening.

§ 771. The necessary cleanliness and avocations of human life require the urine collected to be discharged only at certain times. This discharge of the urine is not only to free the blood of its superfluous water, taken in together with the nutritious chyle, as we see in the thin watry urine that is made soon after drinking, sometimes impregnated with a particular smell or colour of the nourishment; but also a rancid oil, and the dissolved earth, which is rubbed off from the solid parts (§ 235.) must be this way evacuated, which makes the true or yellow urine of the blood, sharp and foetid, as we observe it is discharged a considerable time after meals, more especially in the morning after sleep. From the acrimony of this, in a retention of the urine, the tender vessels of the brain are sometimes eroded with fatal consequences. But these advantages of the urinary secretion could not be joined together, without some danger of disease, from the deposition of the earthy parts of the urine, continually confined and at rest; so that, by repeated additions of the like matter cemented together, a stone may be at length formed. But the plenty of mucus, with which the urinary passages are commonly defended, is, for the most part, a sufficient guard against this disorder, as we see the generality of people are free from the stone;

unless the urine is more than commonly charged with an earthy, tartarous, or chalky matter, increased by the use of hard wines, viscid food, inactivity of body, and a retention of the urine beyond the calls of nature; or finally, a disorder of the kidneys, laying a foundation or basis for the earthy matter first to adhere together.

LECTURE XXXIII.

Of the Genital Parts in Man.

§ 772. **T**HE spermatic vessels constantly arise near those of the kidneys, and almost in all kinds of animals; by which nature seems to have intended a double usefulness in one organ, which might be able to discharge the excrement of urine, and bear a relation likewise to the genital parts, tho' placed at a considerable distance, in a space or interval betwixt the pelvis and thighs, and subservient to cleanliness, modesty, easiness of the birth, and the force of throws in delivery.

§ 773. The semen masculinum is first formed in the testicle, then repositied in the seminal vesicles, afterwards ejected from the penis, and finally received by the uterus, where it renders the female ovum prolific; and therefore, this must be the order of our enquiry into these particulars. The human testicles, but small in proportion to the bulk of the body, are, in the fœtus, lodged within the abdomen behind the peritonæum, from whence, by degrees, they descend into the groins, and are, at last, in a more advanced age, thrust down into the scrotum, perhaps partly by their weight, and partly by the impulse of the influent blood; yet sometimes they are observed to remain behind in the groin of adults. This body is often of an oval figure,

figure, suspended with the smaller end upwards, and the obtuse end downwards.

§ 774. It is defended by various integuments, of which the first and outermost is that of the scrotum, made up of a close cellular stratum, replenished with vessels, and closely adhering to the skin, which last has a kind of elastic or contractile motion, at the approach of cold and in the act of venery, although without any muscular fabric; yet it has commonly action enough to wrinkle the scrotum, and draw up the testicles. Next to this a cellular coat, commonly called dartos, is placed round each of the testicles separately, by the conjunction of which, together in the middle, is formed a kind of septum, which appears more remarkable in a dry preparation; and this septum is often not perforated in its upper part.

§ 775. Within the dartos is spread a loose cellular stratum, without any fat, except in the lower part of the scrotum, and may be inflated like the same substance in other parts. Next follows a muscle, from its office called cremaster; which arises from the degenerating fibres of the less oblique muscle of the abdomen, and from the tendon of the external obliquus, called by some, a ligament, and, by others, fibres, descending from the os pubis backward into a vagina or capsule, which, every way surrounding the testicle, serves to compress, elevate, and forward its contents.

§ 776. Next to this follows the second cellular stratum, whose spongy fabric is continued with the outermost, that lies round the peritonæum;

tonæum; and this second stratum is called tunica vaginalis, in which the vesicles or cells of its fabric, by inflation, appear larger than elsewhere. At the beginning of the testicle, above the epididymus, it is, in a manner, so separated from the rest above the testicle, towards the rings of the abdominal muscles, that the inflation can hardly be continued through. Betwixt this last membrane and the following is a space, into which are exhaled thin vapours, and sometimes a water is collected. The inner coat, called albuginea, is a strong, white, compact membrane, which immediately invests and confines the proper substance of the testicle itself.

§ 777. To the testicle the spermatic artery descends, one on each side, generated by the aorta below the renal arteries; but not unfrequently from the renal arteries themselves; from those of the capsules, or from the aorta itself above the emulgents. This artery, the smallest in the body, in proportion to its length, descends a long way outward before the psoas muscle, and gives small branches to the fat of the kidney, to the ureter, mesocolon, glands of the loins, and to the peritonæum; but more especially towards the bottom of the kidney, it gives a remarkable branch inflected, without lessening itself, that takes a serpentine course behind the peritonæum, as far as the ring of the abdomen. This ring is formed entirely of the tendinous fibres, descending from the external oblique muscle, interrupted in their oblique descent by a long aperture, growing wider downward;

ward; from this aperture most of the smaller inner fibres are broadly detached to the os pubis, and others crossing cohere with the fibres belonging to the other side of the muscle, which, being collected together, is called the inner column. Other stronger external fibres, distinguished from the former by the aperture, are broadly inserted by a thick bundle into the outer side of the os pubis, under the denomination of the external column; from whence various fibres run off in a broad tape to the groin. The upper part of this opening is, in some measure, closed up by fibres, arising from the outer column, and ascending in a curve direction, round the inner and weaker column. Below these fibres there is often a small opening left, parted off by tendinous fibres, through which descends the spermatic artery with the vein, and vas deferens, with a good deal of cellular substance, by which they are wrapt together into a cylindrical cord; from whence, advancing to the groin, it descends into the scrotum, where the spermatic artery gives many small branches to the cremaster, to the cellular coat, and to the septum of the scrotum, and then descends in a double plexus, to the testicle, of which the principal comes from betwixt the epididymis and origin of the vas deferens, at the middle and lower part of the testicle, and then goes, by transverse branches, through the albuginea: the other plexus, that accompanies the vas deferens in the upper part of the testicle, has a like termination. There are other small arteries, which go to the coverings of the
testicle

testicle from the epigastrics, and others from those of the bladder, which follow the course of the vas deferens, both which communicate with the spermatic vessel.

§ 778. Many of these small arteries play about the epididymis; but the larger of them spread transversely thro' the albuginea, which they perforate in several places, to enter the innermost fabric of the testicle, through which they are minutely ramified in all points, and separated by numberless membranous partitions. There is no large anastomosis or communication betwixt the spermatic artery and vein here, any more than in other parts of the body; nor is there any red blood received into those branches that pass through the albuginea to the innermost substance of the testicle. But from the long course of this artery, the smallness of its diameter, the number of serpentine flexures, the great ratio of the dividing branches to their trunk, and the coldness of their subcutaneous distribution, demonstrate, that the blood flows not only in a small quantity, but very slowly to the testicle.

§ 779. The spermatic vein of the right side, is inserted into the cava, but that of the left pours its blood into that emulgent vein, or into both: it is considerably larger than the artery, and takes the same course in company with that; but both its trunk and branches are much larger and more numerous, very serpentine, and formed into a buncy plexus of considerable length, which is interwove with the artery, and continued as low as the testicle; thereby degrees
dividing

dividing into two, like the artery. There are very rarely any valves in this vein. These external coverings of the testicle have arteries from the epigastrics; the scrotum from the crural arteries, and those of the trunk, with an internal branch, which is called *arteria pudenda*; the fellow veins go to the saphena, and to the crural trunks.

§ 780. The nerves of the testicle are many, whence it has a peculiar tenderness of sensation; insomuch that faintings and convulsions follow from bruising or injuring the testicle. Some of them arise deep from the renal plexus, and follow the course of the spermatic vessels. Others are superficial to the coverings of the testicle, from the third pair of the nerves of the loins, and others of that order. I have frequently observed lymphatic vessels in the spermatic cord, which are judged to arise from the testicle itself, and mix themselves with those that accompany the inguinal blood-vessels.

§ 781. The blood moved slowly and in a small quantity through the spermatic artery, by which it is brought to the inner fabric of the testicle (§ 777.), is there drained into exhaling small vessels, which by analogy we judge to be continuous with the seminiferous vessels or ducts, which, bundled together, make up the whole body of the testicle. These seminiferous vessels are exceeding small, serpentine, firm or solid, and have a very small light in proportion to their membranes; they are collected together into bundles, above twenty in number, divided by distinct cells or partitions,

tions, which descend from the albuginea to conduct the arteries and veins. In each of these cells there is a seminiferous duct, to convey the secreted humour from the seminiferous vasculæ. Twenty or more of these ducts form a net-work, adhering to the surface of the albuginea, and forming inosculation one with another. From the said net in the upper part of the epididymis, ascend ten or twelve ducts, which being contorted together into folds, form as many vascular cones, that are joined together by an intermediate cellular substance, and lying incumbent one upon another, then form the epididymis, and soon meet together into one even duct.

§ 782. This duct being intricately wove by an infinite number of folds and serpentine flexures, after a manner not imitated in any other part of the body, and connected together by a great number of loose cellular strata, is afterwards collected by a membrane of the albuginea into one bundle, called the *epididymis*, or appendix of the testicle; which goes round the outer and posterior margin of the testicle, adhering thereto by its thicker head, joined with a good deal of cellular substance, while in its lower, middle, and slenderer part it adheres in some measure, and is in part free, in such a manner, that it intercepts a sort of impervious bag, betwixt itself and the testicle. But the duct of which it is composed, grows larger as it descends, being largest at the bottom of the testicle; from whence again descending
along

along the posterior face of the testicle, in a direction contrary to itself, it by degrees spreads open its spiral convolutions, and comes out much larger, under the denomination of *vas sine ductus deferens*. This is the course described by the semen, propelled forward by the motion of the succeeding juices in the testicle; and perhaps, in some measure, though slowly, by the contraction of the cremaster: as we may reasonably suppose, from the numberless spires and convolutions formed by the epididymis, obstructing almost every kind of injection; and as we may conclude, from the length of time, that is required to fill the seminal vesicles again, after they have been once exhausted.

§ 783. The cylindric ductus deferens being made of a very thick spongy substance, included betwixt two firm membranes, bored through with a very small thread or light, ascends in company with the cord of the spermatic vessels, and together with them, passes through the ring of the abdomen (§ 777.): thence it descends into the pelvis, and applying itself to the bladder, betwixt the ureters, it soon after meets the subjacent receptacles, called the *vesiculæ seminales*. Here it goes along the inner side or edge of the vesicle, as far as the prostate glandule; and dilating in its passage, forms a serpentine flexure, that begins itself to put on a cellular appearance. But very near the prostate it unites in an acute angle, with a conical duct coming out from the vesicle, which does at the same time itself form a conical duct, which emerging out from the prostate, with a
straight-

streightened orifice, opens into the urethra, through a little hollow protuberance, which has a long tail or descent, and is laterally perforated with two very small openings, one on each side. By injecting a liquor into the ductus deferens, of a dead subject, we perceive that it flows both into the urethra and into the seminal vesicle, but more readily into the former; but in a living person the semen never flows out but in the act of venery, and consequently the ductus deferens conveys all its semen, without further delay, over a retrograde angle, to the seminal vesicles.

§784. By this last denomination we call a sort of strong convoluted intestine-like membranes, placed under the basis of the bladder, connected towards its neck by a good deal of cellular substance: from this ten or more blind gut-like cells or intestinuli go off laterally, in some measure ramified and divided, but ending in impervious conical extremities. This kind of intestine, intermixed with a great deal of firm cellular substance, and small vessels, is so contracted together, as to lie within a short serpentine heap. For the rest of its fabric, it seems to have externally a muscular membrane; internally it is wrinkled, having a sort of villous appearance, and is besides said to have small pores and glandules, with which I am unacquainted.

§785. The liquor deposited into this reservoir, is in the testicle yellowish, thin, and watery; and the same nature it retains in the vesicle, only becomes there somewhat thicker
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and higher coloured. It has a sort of heavy or strong smell, of a peculiar kind, in each class of animals. Without the conveyance of this into the womb, no class of animals, of which there are two sexes, can be fecundated so as to propagate their species. The reason of this was thought concealed from us, till the microscope taught, that in man, as well as in all other male animals, the seminal liquor is full of living animalcules, resembling eels, only with a thicker head; and that these are always present in healthy semen, from the time that a person comes of age; but, before that time and in those who are sterile, from a gonorrhæa, they are absent. [That they are animalcules, appears evidently from their various motions, restings, and gestures of body: though with age they are said to dwindle and lose their tails.]

§ 786. It has been much doubted what could be the use of these animalcules, the like of which are not to be found in any other juices of the human body. Some have thought they conduced to irritation of the venereal appetite; and others have had various opinions. However, the majority of anatomists have agreed in this hypothesis; that the seminal vermicle is the first rudiments of a man, almost in the same manner as a caterpillar or grub is the origin of a fly. This seems to be approved, from the near resemblance of the foetus to its parent stamen, from whence it was derived; which stamen does not appear, unless the mother is fecundated by the male. Moreover, this opinion is confirmed, inasmuch as animals generated
from

from the two sexes, have generally a greater resemblance to the father than the mother; in-
somuch, that diseases and defects of body run
for a long time through a family, from the
grand-fathers to the children. Add to this,
that insects commonly undergo an evolution of
their parts, somewhat like this of the vermicle
into a foetus. Again, these vermicles are found
universally in the seed or testicles of animals, and
consequently they seem to be of some very im-
portant use.

§ 787. But many arguments have been like-
wise advanced in opposition to this hypothesis;
the principal of which will be delivered here-
after, in the doctrine by which we are to shew,
that the generation of the parts of the human
body is not made suddenly or together, but
slowly, or by apposition: to which add, that
animals produced from a mixture of kinds,
as the mule, do not shew a perfect delineation
of the male in all the several parts of the
body, but are so far from seeming to proceed
from one parent only, that they shew evident
marks, both of the female, as well as the male
parent; which they ought not to do, if the
parts of the body were first completely deli-
neated in either sex: another great objection
is, the great and useless abundance of these ani-
malcules, in which only one among so many
thousand can come to perfection; to which add
the smallness of the animalcule, compared to
the foetus and its membranes, &c.

§ 788. Every thing considered, the matter
looks altogether obscure; or rather, more
truth

truth seems to appear in behalf of that opinion, which defends a successive formation of the organs: a strong argument for which is, the organical changes made in parts of the greatest consequence, which are very differently disposed in the incipient foetus, from what they are in one that is mature; more especially in the heart, which out of a single canal, is apparently folded together into two auricles, and two ventricles, to which are afterwards added new lungs, a new pulmonary artery and vein, with the first rudiments of the aorta and vena cava, laid so as to correspond one to the other. But experiments on the polype that is found in fresh waters, and on crabs, or earth-worms, and the falling off of harts horns again reparable, with the instances of maimed parts restored in other animals, all demonstrate, that various animal organs, even sufficiently complex and of considerable use, may be repaired again, without the assistance of any previous rudiments, or directing out-lines. In behalf of this a weighty argument is derived from the organical formation of parts, out of a mere fluid, to be observed in many animals, where a gelatinous humour is by degrees hardened or inspissated into teeth, muscles, claws, &c. as in the crab. In this matter we have also the analogy of plants to confirm us; in which the wood and all variety of parts are gradually formed, or built up, in an evident manner, from a fluid condensed within a cellular fabric; while the same power not only continues from the seed to repair all the parts of the plant, but is likewise largely spread throughout every branch

branch of the whole tree; infomuch, that every twig can both produce root, branch, leaf, flower, and fruit.

§ 789. You will then say of what use are the seminal animalcules? whether are they the rudiments of a foetus undetermined; and requiring many changes, by the increase of some parts, and the evolution or shrinking of others, to bring it at length to a human shape, by a successive fabricature? or whether is there any truth at all in the hypothesis; these vermicles which we see being naturally bred in the semen, as the like little eel-like animalcules, are bred in vinegar, or other infusions of herbs? But you will say, if it be so, why are they not to be found in other juices of the human body, not even in the mucous liquor that comes from the female vulva, and stimulates a pleasure in them, like the semen in us.

§ 790. The seminal fluid is retained in the vesicles as long as a man neither exercises venery nor sports in imaginary dreams. But it is always a stimulus to the animal appetite of venery, as long as it is there present in any quantity; but besides this, there is a considerable strong, volatile, and odorous part of the semen, absorbed again into the blood, where it produces wonderful changes, as soon as it begins to be formed, such as the protrusion of the beard, the covering of the pubes, a change of the voice and passions, horns in cattle, &c. for these changes in the animal are not the consequences of age, but of the seminal fluid, and are always absent in eunuchs. The growth and

strength of castrated animals are constantly diminished; and in like manner the fierceness of their temper, and the strong smell of their whole body, are remarkably weakened. A retention of this fluid may follow from a narrowness of the excretory duct, a scirrhusity of the prostate, and other causes not sufficiently known. But, moreover, there are certain vessels very minute and pellucid, which are all along extended from the vesicle, together with the spermatic cord, which are doubtless the absorbing veins of this humour.

§ 791. The quantity of semen expelled at one time from the human vesicles, is but small, more especially in a man who has not long abstained from venery. Therefore, that this fluid might be projected with a greater force, and to a further distance, nature has joined another humour, which is generated by the *prostate*; which is a gland shaped like a heart, with the small end foremost, so as to surround and include the origin of the urethra, but most round its upper side. This is one of the hardest and most compact glands, of a peculiar fabric, yet not evidently conglomerate; it prepares a thick, white, soft, or cream-like liquor in a large quantity, which is poured out at the same time; and from the same causes with the semen itself, into a little valley or channel, at each side of the openings of the seminal vesicles, where mixing with the seminal fluid, it imparts thereto the white colour and viscosity with which it is predominant.

§ 792. But it was necessary for this canal of the urethra to be firm and capable of a direct figure, that it might be able to throw the semen with some strength into the distant womb; and therefore a three-fold cavernous body surrounds it. The first and proper cavernous body of the urethra, begins as soon as that canal has passed the prostate, with a thick origin, almost like a heart, first under the urethra, and then above it, but thinner; from thence it surrounds the whole canal, through the whole length of the penis, till the lower part terminates in the glans, while the upper part is reflected back from the extremity of the urethra, and expanded in such a manner about it as to form the glans; which being circumscribed by a broad circumference, gradually extenuated, and somewhat round, terminates the extremities of the cavernous bodies, upon which it is incumbent. The fabric of the glans is cellular, but of a larger sort than the cells of the cavernous bodies, being composed rather of plates than fibres, interwove like a net, and intercepted betwixt two firm membranes.

§ 793. Into this cavernous body of the urethra, the blood is poured out from the arteries, which come from deep branches, sent off from the external hæmorrhoidals (§ 797.), the truth of which is demonstrated by the injection of any kind of fluid; which being urged into the said arteries, easily flows into these cellular spaces, surrounding the urethra. But these are not naturally turgid with blood, because there are veins open and numerous enough in

proportion to drink up, and return what is poured in by the arteries; but if the return is impeded by compressing those veins from the powers hereafter mentioned (§ 800.), the blood is then retained within the cellular spaces, while the arteries continue to import it more swiftly and strongly than the veins return it. Thus the stagnant blood distends the bulb of the urethra, together with its cavernous body, and the glans itself. But this is performed generally at the same time, when the other cavernous bodies of the penis, with which this of the urethra has no communication, are likewise rigidly distended.

§ 794. But the cavernous bodies of the penis arise from the ossa ischii and pubis, where they are conjoined by a white, cellular, very dense and firm substance; from whence inclining inward towards each other, they take betwixt them the urethra, a little before its bulb, where changing their direction, they go on parallel, conjoined together, and with the urethra extended forward along their middle, and terminate with an obtuse end in the glans. These bodies are covered with a very firm integument, and their internal flesh is spongy, like that of the urethra (§ 793.), like which it is capable of being distended by the reception of the blood. Betwixt them there is a middle septum or partition, composed of firm parallel tendinous fibres, growing narrower downward; but not continuous one to another, that the intermediate spaces might be larger and more numerous, as they are more forward; and that they

they might leave a free communication betwixt the right and left spongy body. Other such robust fibres, like cross-beams, run through the cavernous bodies, and are inserted into the sides of their membranous sack, so as to prevent an aneurism or over distention of the penis.

§ 795. These cavernous bodies are surrounded with a good deal of tendinous and cellular substance, of which that side lying next the cavernous bodies is dense and firm, like a membrane; but from thence outward, towards the skin, its fabric is cellular and very tender, without including any fat, and continuous with the cellular membrane of the scrotum. But the glans (§ 792.) is naturally covered in such a manner, that the skin is continued from the penis, and folded back against itself, as we observe in the eye-lids; both folds of the skin being covered with its proper cuticle, and stuffed or filled up, each with its proper cellular stratum, under the name of *preputium*, or prepuce, which may be like a cap drawn back from, and again brought over the glans; at which it changes into a tender papillary body, covered with its proper cuticle and cellular substance, spread over the reflected cavernous body of the urethra (§ 792.); and finally is continued with the membrane of the urethra itself. The said prepuce is tied by a double triangular ligament, by which the common skin is conjoined to that which makes the covering of the glans. Upon the excavation that surrounds the crown of the glans, as well as upon the crown itself, are seated simple sebaceous follicles,

which separate a liment of a peculiar, somewhat fœtid smell, from the nature of their seat, serving to abate the attrition of the skin, as in other parts of the body. Finally, the whole body of the penis is sustained by a firm cellular plate, compacted into a kind of triangular ligament, which descends from the sychondrosis of the ossa pubis; and is from thence continued into the dense cellular stratum, that surrounds the hard cavernous bodies.

§ 796. These cavernous bodies then of the penis, having their spongy fabric distended, by the blood retained by the veins, and still propelled by the arteries, become rigidly turgid, and sustain the otherwise flaccid, or but weakly filled urethra, in such a manner that it may be able to conduct the semen into the distant womb. All this is demonstrated from the dissection of brute animals in the act of venery, from an artificial erection, and from the injection of liquid matters into the vessels of the penis. But the cause of this distention remains still to be explained. The distribution of the blood-vessels into the genital parts are therefore to be here described, to make it evident how ready the compressing cause constantly is to act upon the veins.

§ 797. The aorta at the fourth vertebra of the loins, and the vena cava at the fifth, are bifurcated or divided, the former before the latter. The common iliac branches, not yet arrived to the middle of the interval in the thighs, send off inward and downward, a considerable artery, called the hypogastric, which in the
foetus

fœtus is larger than the femoral artery, and in the adult is equal to it. This descending into the pelvis, divides into four, five, or six principal branches, of which the first is the iliacus anterior, which supplies branches upward, to the dura mater and cauda equina of the spine, and into the os sacrum. The next, or sacralateral artery goes off from the bone of that name, when it does not arise from the former; and the third or iliaca-posterior, is distributed to the glutei muscles. The fourth is the ischiatica descendens, to several muscles, nerves, and levators of the anus. The fifth trunk is that of the hæmorrhoidæ infima sive pudenda communis, which in the cavity of the pelvis sends considerable branches to the bladder and rectum; after which, joining with the mesenterics, and going out of the pelvis, it creeps by the side of the obturator, and gives off the external hæmorrhoidæ, to the sphincter and skin of the anus; then dividing, it goes with an internal branch to the bulb of the urethra, surface of the prostate, and inside of the corpus cavernosum penis, while by another branch it runs along the back of the penis, according to the direction of its bodies, and terminates with them by ramifications into the skin. The sixth is the obturatrix, spent upon the joint of the femur and adjacent muscles. The last is the umbilical artery, to be described in treating of the fœtus; although in adults it sends off some branches to the bladder, from its thick callous body or vagina. Sometimes one or more of these arteries come from the common trunk.

The skin of the penis and scrotum have their arteries from the epigastric, and from the internal branch of the crural. These external arteries communicate in many places with the external.

§ 798. The veins are, in general, distributed in like order with the arteries; they come off in two trunks from the iliacs, joining together into a net, and then the hæmorrhoidal vein, bending round under the os pubis, forms a large plexus, spread with the veins of the pelvis upon the prostate and seminal vesicles; from hence the great vena dorsi penis arises, which is often single, and furnished with valves to forward the return of the blood. The external veins go to the sphenæ and crural, communicating in several places with the internal veins, more especially at the basis of the præpuce.

§ 799. Lymphatic vessels of the penis are, by most eminent anatomists, said to run under the skin towards the groins. The nerves of this part are both numerous and very large, and accompany the arteries of the penis, from the trunk of the great sciatic nerve. But the bladder, rectum, and uterus are supplied by the lower mesenteric plexus, which arises from the middle one (§ 763.), descending into the pelvis.

§ 800. In order to distend the penis, there must be either a compressure of the great vein (§ 798.), or a constriction of the lesser veins, that every where open within the cavernous bodies to hinder them from absorbing and returning the blood from the arteries. The first, how-

however, may be effected by the levator, drawing up the prostate; but it is very probable, that as we see in the nipples of the suckling mother, in the gills of the peacock, and in the blushing or redness of the face, from passions of the mind, as well as from brute animals, which all couple without the use of any erector muscle; from all these it is probable, that the course of the blood through the vein may be retarded, without the immediate use of any muscle; and that, by the power of the latent multitude of small nervous bridges, by whose constriction, from the force of pleasure, the veins are compressed and straitened, so as to return less blood to the trunks, at that time, than what is imported by the arteries. But the cause of this constriction in the nervous bridges, or sphincters themselves, depends upon a various irritation of the nerves, belonging to the penis and urethra, either from an external friction, or from venereal thoughts or dreams, a redundancy of good semen, a distention of the bladder with urine, or a greater determination of the blood's course to the abdomen, after a meal; or lastly, from various irritations by diuretic medicines, poisons, stripes or flogging, epilepsies, or like irritation.

§ 801. A long continued and violent erection is commonly joined, at last, with an expulsion of the semen, at that time, when, at length, the cellular spaces of the urethra and its continuous glands, which are at last filled, become so far distended, with a large quantity of warm blood, that the nervous papillæ, stretched

stretched out in the latter, become violently affected from the irritating or pleasurable cause; and hereupon the seminal vesicles are evacuated by the levator muscles of the anus, which press them against the resisting bladder with a convulsive motion, excited either by a voluptuous imagination, or from the pruritus, that is exquisite in the nerves of the glans. Hence the semen is never discharged with any of the urine, in an healthy man; because the expulsion of it requires the bladder to be closed or drawn up firmly together; for, while lax, it affords little or no resistance to the seminal vesicles. At the same time, with the levators, acts the compressor of the prostate, a broad thin muscle, not constantly found, arising from the os pubis, at its meeting with a branch of the ischium, and inserted into the anus and bulb of the urethra, largely expanded together with its fellow muscle over the prostate. The transverse muscles, which are one, two, or three, arise in common with the os ischium, at the beginning of the erector, whence its principal bundles, going betwixt the anus and bulb of the urethra, conjoin together, and seem to dilate the canal for the reception of the semen, expressed from the vesicles.

§ 802. Soon afterwards the powers, constringing the urethra, are, from the irritation of the very sensible fabric of that canal, put into action. To this constriction conduce principally the accelerator (§ 769.), which makes a powerful concussion of the bulb and adjacent part of the urethra, so as to propel the contents more swiftly,

swiftly, in proportion as the bulb has a larger diameter than that of the urethra. But that this may act firmly, the sphincter of the anus, together with that of the bladder, must be well shut. The accelerator muscle seems also principally concerned in the erection, by compressing the veins of the corpus cavernosum of the urethra. At the same time the erectores penis, as they are called, arising from the tubercles of the ischium, become strong and are inserted into the cavernous bodies, sustaining the penis, as a sort of medium, betwixt the transverse and perpendicular direction. Thus the semen is drove, either into the vagina or uterus itself, in a prolific coition; the whole action of which is very impetuous, and comes near to a convulsion; whence it wonderfully weakens the habit, and largely injures the whole nervous system.

LECTURE XXXIV.

Of the Virgin Uterus.

§ 803. **T**HE uterus is seated in the upper part of the pelvis, with the bladder before, and the rectum behind it, without adhering to either of them. In women, the peritonæum descends from the os pubis into the pelvis, over the posterior face of the bladder, down to the bottom or mouth of the uterus: from whence again it ascends over the foreside of the uterus, and, passing round its convexity, descends on the posterior side down to the vagina, from whence it extends laterally or transversely on each side, including the rectum with lunated folds, which is all the difference betwixt the female and male peritonæum. But this same peritonæum, coming into the pelvis from the iliac vessels, and broadly adhering to the sides of the uterus and vagina, is folded back over itself, and divides the pelvis almost into two, like a partition, under the denomination of ligamentum latum. Thus the peritonæum accurately connects the uterus, without the intervention of any fat, so as to serve it on all sides, as an external coat or covering.

§ 804. The figure of the uterus is somewhat like a depressed pear, flatly convex before, round behind, with acute edges on each side, and at the meeting of its convexities; but converging,
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gradually afterwards for some way, in its upper part, almost parallel. It has a peculiar fabric, being made up of a close, firm, but somewhat succulent and cellular flesh, in which we perceive the appearance of muscular fibres, more especially in the gravid uterus, disposed in various circles, and particularly at the fundus betwixt the tubes. As for any mucous sinusses, variously branching and dividing within the flesh of the uterus, after repeated enquiries, we now declare, that we have not been able to find any; only some common small vessels, surrounded with cellular substance, by which their diameters are sustained. The internal membrane of the uterus is scarcely distinguishable or separable; but such a one there is, continued from the cuticle, in the upper part of the cavity, fleecy, and in the lower part, callous, like valves. The cavity of the uterus is small, for the most part triangular upward, and below like a compressed cylinder. The cylindric part, which is called the cervix or neck, is altogether rough, with callous wrinkles rising up into an edge, whence they incline towards the vagina; these recede laterally from the anterior and posterior margin, joining together by small wrinkles, in the intervals of which are small mucous sinusses, with small pellucid spherules, filled with a very clear liquor, in some parts interspersed through the upper region of the cervix uteri, differing both in their number and magnitude. It is not uncommon for the uterus to be distinguished by a line or protuberance extended through its middle. The

cervix is terminated, by the os internum uteri, with a transverse rim, forming protuberant lips, which project for some length into the vagina; there are also mucous sinusses, filled with a viscid mucilage, about the tumid lips and their sinuosities.

§ 805. The triangular part of the uterus sends out, from its lateral angles, two canals, in some measure folded together by the cellular substance, growing gradually broader, like a trumpet, and, being again a little contracted towards their extremity, they proceed towards the ovary, first in a transverse direction, and afterwards a little descending, but with some variation, under the denomination of the uterine tubes. Their external membrane is from the peritonæum, for they are included within the duplicature of the broad ligament (§ 803.), which is a production of that membrane; internally they are wrinkled almost reticularly, lined with mucus, extended to a considerable length by intervening plates or folds, and terminated in a sort of fringe or ruffle, that broadly crowns the opening of the tube, which is also connected to the ovary. Betwixt the two membranes is something of a spongy cellular substance, of a slender texture. There are also great numbers of vessels, and perhaps some muscular fibres, but the latter are more obscure.

§ 806. But the *ovaries*, included in the same duplicature of the broad ligament behind the tubes, are seated transversely, and conjoined

to the said tubes by a ligamentary expansionⁿ of their own, which is long enough to allow them a free motion; they are somewhat of an oblong or oval figure, depressed on each side, convex upon their unconnected side, and half elliptical, extending somewhat longer than the other thin side, which is more direct and connected to the ligament; their fabric nearly enough resembles that of the uterus itself, being a close, white, cellular substance, compacted together, without any fat. But even in the virgin ovary there are small, round, lymphatic spherules, formed of a pulpy, and somewhat firm membrane, which are filled with a coagulable lymph, of an uncertain number, to twelve in one ovary. The margin of the broad ligament, receding from the uterus to sustain the ovary, has something of a more solid and thick substance, resembling a ligament.

§ 807. Lastly, the uterus sends out, from the same lateral angles, of its triangular body downward, a kind of fasciculus, composed of long cellular fibres and small vessels, which, becoming small in their progress, goes out of the pelvis through the ring of the abdomen (§ 777.) into the groin, where it splits into branches, and dissolves into small vessels, which communicate with the epigastrics. Whether or no it has any long fibres propagated from the uterus itself, does not plainly appear.

§ 808. The arteries of the uterus are from the hypogastrics, a considerable branch of which goes off, like that to the bottom of the bladder in men, or, at least, it arises from the umbilical

bilical trunk, or immediately below that trunk, and makes the common artery, belonging to the uterus, bladder, and rectum; upon the lower parts of which it spreads, and, ascending upward, forms various inosculations with the spermatics. These last vessels have the same origin as in men (§ 778.), and form a plexus, which, from its similitude to the tendrils of a vine, is called pampiniformis; afterwards, descending over the psoas muscle into the pelvis, it divides into two plexusses, the anterior of which surrounds the ovary itself, with many circles, elegantly distributed thro' its substance. The posterior both supplies the tube, and descends to the uterus itself, in which it sends out winding branches upward and downward, and some branches that are detached to the bladder. Another artery is the middle hæmorrhoidal, coming from the common trunk of the pudendal, a considerable way forward with the vagina; to which, and to the bladder and rectum, it is distributed. The beginning of the vagina likewise, and the clitoris, have arteries from the external hæmorrhoidal, which are distributed like those of the penis, some inwardly, others superficially.

§ 809. The course of the uterine veins is like to that of the arteries, forming a plexus from the external hæmorrhoidal, or from those of the bladder, conjunctly to which go those of the clitoris, after the manner we described in the penis (§ 798). Valves there are none in these veins, except a few in the spermatics. Lymphatic vessels are frequently seen in the uterus of brute animals; but, in the human species,

species, there are not yet any discovered, at least by my own observation. The nerves are supplied from the lower mesocolic plexus, which sends out large branches to the bladder, womb, and rectum; besides which, there are a few nervous twigs, which descend through the broad ligament to the ovaries, and others from the nerve, that goes with the vessels to the clitoris. The great number of the nerves, therefore, make these parts extremely sensible.

§ 810. The descriptions, we have hitherto given, are in common to all ages of the female; but about the 13th or 14th year, near at the same time when semen begins to form itself in the male, there are likewise considerable changes produced in the female. For, at this time, the whole mass of blood begins to circulate in the girl with an increased force, the breasts are filled out, the pubes begin to be cloathed, and, at the same time, the menses, in some measure, make their appearance. But before the menstrual flux, there are various symptoms excited in the loins, heavy pains, head-achs, and cutaneous pustules commonly proceed. For now the fleecy vessels of the uterus, which, in the state of the fœtus, were white, and transfused a sort of milk, as, in the young girl, they transfused a serous liquor, do now begin to swell with blood; the red parts of which are deposited thro' the vessels, into the cavity of the uterus. This continues some days, while, in the mean time, the first troublesome symptoms abate, and the uterine vessels, gradually contracting their openings, again

distil only a little serous moisture, as before. But then the same efforts return again, at uncertain intervals in tender virgins, till, at length, by degrees, they keep near to the end of the fourth week, at which time follows the flux of blood, as before, which is periodically continued to about the 50th year; though the diet, country, constitution, and way of life, cause a great variation in this discharge.

§ 811. This discharge of blood, from the vessels of the uterus itself, is demonstrated by inspection, in women who have died in the midst of their courses; and, in living women, who having an inversion of the uterus, the blood has been seen plainly to distil from the open orifices: it also appears from the nature of the uterus itself, full of soft spongy vessels, compared with the thin, callous, little fleecy, and almost bloodless substance of the vagina. But that this is a good and sound blood, in a healthy woman, appears both from the foregoing and innumerable other observations.

§ 812. Since none, but the human species, are properly subject to this menstrual flux of blood, (although there are some animals, who, at the time of their vernal copulation, distil a small quantity of blood from their genitals) and since the body of the male is always free from the like discharge, it has been a great enquiry, in all ages, what should be the cause of this sanguine excretion, peculiar to the fair sex. To this effect, the attraction of the moon, which is known to raise the tides of the sea, has been accused in all ages; others have referred

ferred it to a sharp stimulating humour, secreted in the genital parts themselves. But if the moon was the parent of this effect, it would appear, in all women, at the same time, which is contrary to experience; since there is never a day, in which there are not many women seized with this flux, nor are there fewer in the decrease, than the increase of the moon. As to any sharp ferment seated in the uterus or its parts, it will be always enquired for in vain, where there are none but mild mucous juices, and where venery, which expels all those juices, neither increases nor lessens the menstrual flux; but lastly, that it proceeds entirely from a plethora or too great a fulness of blood, appears from hence; that, by a retention, the courses have been known to break thro' all the other organs of the body, where no vellicating ferment could be seated, even so as to burst open the vessels of each organ.

§ 813. Nature has, in general, given women a body with softer or looser vessels, and solids that are less elastic; their muscles are also smaller, with a greater quantity of fat interposed both betwixt them and their fibres; the bones too are slenderer and less solid, and their surfaces have fewer processes and asperities. Moreover, the pelvis of the female is, in all its dimensions, larger; the ossa ilia spread farther from each other, and the os sacrum recedes more backward from the bones of the pubes, while the ossa ischii depart more from each other below; but above all, the angle, in which the bones of the pubes meet together

to form an arch, is, in the female, remarkably more large or obtuse. Moreover, the hypogastric and uterine arteries are considerably larger in women than in men, and have a greater proportion of light, with respect to the thickness of their coats; but the veins are, in proportion, less ample than in the men, and of more firm resisting texture, than in other parts of the body. From hence it follows, that the blood, brought by the arterial trunk to the womb, by passing from a weaker artery into a narrow and more resisting vein, will meet with a more difficult return, and consequently endeavour to escape or go off by the lateral vessels.

§ 814. The female infant new-born has her lower limbs very small, and the greater part of the blood, belonging to the iliac arteries, goes to the umbilicals, sending down only a small portion to the pelvis, which is consequently small, and but little concave; so that the bladder and uterus itself, with the ovaries, project beyond the rim of the pelvis. But when the umbilical artery is tied, all the blood of the iliac artery descends to the pelvis and lower limbs, which, of course, grow larger, and the pelvis spreads wider and deeper: so that, by degrees, the womb and bladder are received into its cavity, without being any longer compressed by the intestines and peritonæum, when the abdominal muscles urge down upon the lower parts of the abdomen.

§ 815. When the growth is advanced to puberty, we find the arteries of the uterus
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and pelvis universally larger, which, in the fœtus, were extremely small; and so much are they all changed, that the hæmorrhoidal artery serves now as a trunk to the hypogastric (§ 797.), instead of what was before the umbilical artery. Therefore, at this age of life, a greater quantity of blood will be sent to the uterus, vagina, and clitoris, than was before usual.

§ 816. At the same time, when the growth of the body begins considerably to diminish, the blood, finding easy admittance into the compleated viscera, is made in a greater quantity, the appetite being now very sharp in either sex, in both which a plethora from thence follows, which, in the male, vents itself frequently by the nose, from the exhaling vessels of the pituitary membrane being dilated to so great a degree without a rupture, as to let the red blood distil through them (§ 459.). But, in the female, the same plethora finds a more easy vent downward, being that way directed partly by the weight of the blood itself, to the uterine vessels now much enlarged, of a soft fleecy fabric, seated in a loose hollow part, with a great deal of cellular fabric interspersed, which is very yielding and succulent, as we observe in the womb; for these causes, the vessels being easily distensible, the blood finds a more easy passage through the very soft fleecy exhaling vessels, which open into the cavity of the uterus, as being there less resisted than in its return by the veins, or in taking a course through any other part; because, in females, we observe the arteries of the head

are both smaller in proportion, and of a more firm resisting texture. The blood is, therefore, first collected in the blood of the uterus, which, at this time, by repeated dissections, are observed turgid or swelled; next it is accumulated in the arteries of the loins and the aorta itself, which, urging on a new torrent of blood, impelled from the heart by degrees, augments the force, so far as to open and wedge the red blood into the serous vessels, which, at first, transmit an increased quantity of warm mucus, afterward a reddish coloured serum, and, by further opening, they, at last, emit the red blood itself, which, however, in this discharge, has usually a greater proportion of serum. The same greater impulse of blood, determined to the genital parts, drives out the hitherto latent hairs, increases the bulk of the clitoris, dilates the cavernous plexus of the vagina, and whets the female appetite towards venery. Accordingly we find, that the quantity of the menstrual flux and the earliness of their appearance are promoted by every thing, that either increases the quantity or momentum of the blood, with respect to the body in general, or which direct the course of the blood more particularly towards the uterus; such as joy, lust, bathing of the feet, &c.

§ 817. When six or eight ounces of blood have been thus evacuated, the unloaded arteries now exert a greater force of elasticity, and, like all arteries that have been overcharged with blood, contract themselves by degrees, to a less diameter, so as, at length, to give passage
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only to the former thin exhaling moisture; but the plethora or quantity of blood, being again increased from the same causes, a like discharge will always more easily ensue, or return thro' the vessels of the uterus, after they have been once thus opened; so that, except in extraordinary cases, it rarely seeks for a different passage. Nor is there any occasion to perplex ourselves about the cause, why this periodical discharge is, for the most part, nearly regular or menstrual; for this depends upon the proportion of the quantity and momentum of the blood daily collected, together with the resistance of the uterus, which is to yield again gradually to the first course. Therefore this critical discharge of blood never waits for the interval of a month, but flows sooner or later, according as the greater quantity of blood, in plethoric women, is determined by lust, or other causes, towards the uterus. Finally, they cease to flow altogether, when the uterus, like all the other solid parts of the body, has acquired so great a degree of hardness and resistance, as cannot be overcome by the declining force of the heart and arteries, by which the blood and juices are drove on through all the vessels. This increased hardness in the old uterus is so remarkable in the arteries and ovaries, that it easily discovers itself both to the knife and the injections of the anatomist. But, in general, brute animals have no courses, because, in them, the womb is, in a manner, rather membranous than fleshy, with very firm or resisting vessels,

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which,

which, with the difference of their posture, never permit a natural hæmorrhage from the genital parts.

§ 818. It will, perhaps, be demanded, why the breasts fill out at the same time with the approach of the menses? we are to observe, that the breasts have many particulars in their fabric, common to that of the uterus, as appears from the secretion of the milk in them, after the birth of the fœtus, which increases or diminishes, in proportion as the lochial flux is either increased or diminished; from the similitude of the serous liquor, like whey, found in the uterus, so as to resemble milk, in those who do not suckle their children, being of a thin and white consistence, appearing very evidently in brute animals; also from the turgescence or erection of the papillæ or nipples of the breast by friction, analogous to the erection of the clitoris. Therefore the same cause, which distend the vessels of the uterus, likewise determine the blood more plentifully to the breasts; the consequence of which is an increased bulk and turgescence of the conglomerate glandules and cellular fabric, which compose the breasts.

LECTURE XXXV.

Of the Pregnant Uterus.

§ 819. **I**N the preceding condition the uterus constantly remains, unless, by congress with the male, it becomes impregnated; towards which, nature has given women a covetous appetite, as well as for the taking of food; and for this she has likewise framed peculiar organs. She has first added to the womb a vagina or round membranous cavity, easily dilatable, which, as we have already seen (§ 804.), embraces and surrounds the projecting mouth of the uterus; from whence it descends obliquely forward under the bladder, which lies before it, and resting upon the rectum with which it adheres, and advances to an opening sufficiently large below the urethra. This opening, in the foetus and in virgins, has a remarkable wrinkled valve, formed as a production of the skin and cuticle, under the denomination of *hymen*, which serves to exclude the air or water, and afford some signs of chastity. It is circular, excepting a small deficiency under the urethra, which yet is not always constant, but spreads itself very broadly below, towards the anus. This membrane, if not previously injured by disease or violence, is broke in the first congress; and, in length of time, its lacerated portions almost disappear.

§ 820.

§ 820. The fabric of the vagina is somewhat like that of the skin, composed of a firm, dense or callous cuticle, covering a thick, white, nervous skin, in which, more especially at its end, appear fleshy fibres. Its internal surface is, in a great measure, rough, beset with many callous warts, which, tho' hard, are sensible; besides which, there are thin plates, terminated with a protuberant inclined edge, pointing downward, so as to form two principal rows, spreading betwixt those warts; and of these, the uppermost are extended under the urethra, where they are larger, as the lower are incumbent on the anus. From each of these to the other are continued, on both sides, several rows of lesser valve-like papillæ, variously inflected into arches, and which seem to be designed for increasing the pleasure, and facilitating the expansion when it is called for. It is furnished with a proper mucus of its own, separated from particular sinusses in several parts, but more especially in its posterior and smoother side.

§ 821. At the entrance of the vagina are prefixed two cutaneous productions or appendages, called *nymphæ*, continued from the cutis of the clitoris, and from the glans itself of that part; and these, being full of cellular substance in their middle, are of a turgescient or distendible fabric, jagged and replenished with sebaceous glandules on each side; such as are also found in the folds of the præpuce, belonging to the clitoris. Their use is principally to direct the urine, which flows betwixt them
both

both from the urethra, that, in its descent, it may be turned off from clinging to the body, in which office the nymphæ are drawn together with a sort of erection. These membranous productions descend from the cutaneous arch surrounding the clitoris, which is a part extremely sensible, and wonderfully influenced by titillation; for which it is made up, like the penis, of two cavernous bodies, arising, in like manner, from the same bones (§ 794.), and afterwards conjoining together, in one body, but without including any urethra. It is furnished with blood-vessels, nerves, and levator muscles, like those of the penis (§ 794.), like unto which the clitoris grows turgid and erect in the venereal congress, but less in those who are very modest.

§ 822. At the outer sides of the vagina, where the cutaneous lips are continued into large folds, to guard or defend the whole pudenda, there is a large surrounding plexus of veins, formed by the ultimate branches of the external hæmorrhoidal veins. This plexus, both from the right and left side, are conjoined together with the middle plexus, in the upper part of the vagina, above the clitoris; but a good deal of the fabric is here obscure. Into those plexusses the blood impetuously flows, at the time of venereal irritation, so as to straighten the vagina, and increase the pleasure of both sexes. To the same purpose also conduces the muscle, termed *ostii vaginae constrictor*, which, arising on each side from the sphincter of the anus, and from within the
tubercle

tubercle of the os ischium, covers the vascular plexus of the perineum, from whence it proceeds outward in the direction of the labina externa, and is inserted into the crura clitoridis; thus it seems to compress the lateral venal plexusses of the vagina, and that of the perinæum, which are derived from the external hæmorrhoidals; whence it every way conduces to retard the return of the venal blood.

§ 823. When a woman, invited either by moral love, or a lustful desire of pleasure, admits the embraces of the male, it excites a convulsive constriction and attrition of the very sensible and tender parts, which lie within the contiguity of the external opening of the vagina, after the same manner as we observed before of the male (§ 801.); by these means the return of the venal blood being suppressed, the clitoris grows turgid and erect, the nymphæ swell on each side, as well as the venal plexus, which almost surrounds the whole vagina, so as to raise the pleasure to the highest pitch; in consequence of which there is expelled, by the muscular force of the constrictor (§ 822.), but not perpetually, a quantity of lubricating mucous liquor, of various kinds. The principal fountains of this are seated, at the first beginning or opening of the urethra, where there are large mucous sinusses, placed in the protuberant margin of this uriniferous canal. Moreover, there are two or three large mucous sinusses, which open themselves into the cavity of the vagina itself; and others at the sides of the urethra in the bottom of the sinusses, which

which are formed by the membranous valves, fulcated upward. Lastly, at the sides of the vagina, betwixt the bottoms of the nymphæ and the hymen, there is one opening, on each side, from a very long duct; which, descending towards the anus, receives its mucus from a number of very small follicles.

§ 824. But the same action which, by increasing the heights of pleasure, causes a greater conflux of blood to the whole genital system of the female (§ 551, &c.), occasions a much more important alteration in the interior parts. For the hot male semen, penetrating the tender and sensible cavity of the uterus, which is itself now turgid with influent blood, does there excite, at the same time, a turgescence and distention of the lateral tubes, which are very full of vessels, creeping betwixt their two coats; and these tubes, thus copiously filled and florid with the red blood, become erect and ascend, so as to apply the ruffle or fingered opening of the tube to the ovary. In the truth of all these particular changes, we are confirmed by dissections of gravid or pregnant women, under various circumstances, also from the comparative anatomy of brute animals, and from the appearances of the parts when diseased.

§ 825. But, in a female of ripe years, the ovary is extremely turgid, with a lymphatic fluid, which will harden like the white of an egg, and with which little bladders are distended. Also, before the conception, there is generally formed, by degrees, a kind of yellow coagu-

coagulum, within some vesicle of the ovary (§ 806.), as I have frequently seen, which substance increasing very much by degrees, the coat of the vesicle disappears, and it changes into a hemispherical yellow body (*corpus luteum*), somewhat like a bunch of currants; which body is inwardly hollow, and includes in its cavity, as far as we can perceive, the very minute hollow membranes or eggs, which are to be the seats of future fœtus's. The extremity of the tube, therefore, surrounding and compressing the ovarium in the fervent congress, presses out and swallows a mature ovum, from a fissure in the outer membrane, from whence it is continued down, by the peristaltic motion of the tube, to the uterus itself, which peristaltic motion begins from the first point of contact with the ovum, and urges the same downward successively to the opening into the fundus uteri. The truth of this appears from the perpetuity of the corpora lutea, which are never absent in prolific women, but always form a protuberance; from the repeated and constant observation, of the number of scars or fissures in the ovarium, being always conformable to the number of fœtusses excluded by the mother; and however small the ovum is found in the tube, which is itself narrow, yet the entrance of it thro' the uterus is so much narrower, that the vesicle can scarce pass along that way with its figure entire. Yet we must acknowledge, that the ovum was never truly observed, included within its yellow calix, in passing the tube.

§ 826. This conveyance of the ovum is not performed without great pleasure to the mother, nor without an exquisite unrelatable sensation of the internal parts of the tube, threatening a swoon or fainting fit to the future mother. Thus, at length, a conception ensues, when the ovum is so changed by the male semen, that the first rudiments of an incipient foetus are therein begun; whether that be from a vermicle entering into the ovum, as a new inhabitant, or from the spirituous part of the semen, exciting a new vital motion in the fluids of the ovum itself; for hitherto there are no observations, which countenance a previous delineation of the foetus in the ovum; no such marks can be seen in the virgin ovum, and the foetus, which is produced from unlike parents, resembles the father more than the mother; also the ova, which are, in all respects, perfect on the side of the female, so as to resemble those which are truly prolific, do, notwithstanding, always prove sterile, and bring forth nothing without the male semen.

§ 827. It may be demanded, whether the seat of conception be in some certain part of the uterus, to which experiments shew, that the male semen is conveyed? or whether the energy of the male semen impregnates the ovum, while it is yet lodged in the ovary; as would seem to follow from the examples of foetusses, found in and about the ovarium, and in the tube? to which add the evident changes, that are produced by prolific venery in the corpus luteum; and the analogy of the feathered kind;

kind, in which, after the congress, there is but one ovum falls into the womb; tho', at the same time, a great number are fœcundated in the ovary from one single tread; nor is the smallness of the quantity, or sluggishness of the motion observeable in the male semen, any objection to this system, tho' some may imagine from thence, that it is not able to penetrate so far thro' such narrow tubes. For that the tubes themselves are in a recent impregnation, replenished with the male semen, is evident even to demonstration or inspection, as well in mankind as in brute animals.

§ 828. After conception, we know certainly, that the uterus in brute animals, closes itself; and it most probably does the same in our own species; that so the prepared and slender ovum, together with the expected fruit or fœtus, may not be lost, to the disappointment of nature in her intention. After the human ovum has lain some days in the womb, we begin to learn its changes more sensibly. The ovum itself sends out, on all sides fleecy soft branches from its including membrane, which is as yet simple; these fleeces, inosculate and cohere with others of the same form, belonging to the flocculent, exhaling and absorbing vessels of the uterus internally (§ 805.). This adhesion of the ovum is made in all parts of the uterus, but more especially in its thicker part, which lies betwixt the entrance of the tubes, commonly called the fundus. By this communication a thin serous humour passes from the villous arteries of the uterus, into the receiving small veins of the ovum,

the receiving small veins of the ovum, which is thereby nourished, together with its included fœtus; but before this adhesion, it is either nourished by the matter it already contains, or else by such juices as it absorbs from the surrounding humours.

§ 829. At this time, in the ovum, there is, a great proportion of a limpid watery liquor, which, like the white of an egg, hardens by the heat of fire, or a mixture with alcohol; and now the invisible fœtus first appears, with a very great head, a small slender body, and as yet without limbs, fixed by a very broad flat navel-string to the obtuse end of the ovum. From hence forward the fœtus continually increases, as well as the ovum, but in a variable, unequal proportion; for while the arterial serum is conveyed by more open passages into the smaller vessels of the ovum, the fœtus itself grows the fastest; because now the greatest part of its nourishment seems to pass thro' the ample and open umbilical vein. At the same time the ovum itself also grows, but less in proportion; and the waters, which it includes, gradually diminish from their first proportion, in respect of the bulk of the fœtus. The fleecy productions of the vessels from the ovum are gradually spread over with a continued membrane, which makes the chorion; betwixt which and the amnios they are intercepted; of these the greater part disappear below, or else terminate in the chorion, and only those which sprout out from the obtuse end of the ovum, take root, or increase so as to form a round circumscribed placenta or cake.

§ 830. Such is the appearance of the ovum, as we have here described it, commonly in the second month; from whence forward it changes only by increasing in bulk. That part of the ovum next the fundus uteri is commonly uppermost, making about a third of its whole surface, in form of a flat round dish or plate; succulent and full of protuberances, but throughout perfectly vascular, uniting and interlocking with other tubercles of the same kind, and with a thin cellular fabric of the uterus itself; which being without fat, accurately collects and conjoins the small vessels of the uterus, as exhaling arteries, so as to correspond inseparably with the inhaling or absorbing veins of the placenta, and the wide opening veins of this last to the veins of the uterus. This communication of the vessels, appears evident, from the loss of blood which follows from a separation of the placenta in a miscarriage; and from the blood of the foetus being exhausted from an hæmorrhage in the mother; from hæmorrhages that ensue from the navel-string, so as to kill the mother when the placenta has been left adhering to the uterus; and lastly, from the passage of water, quicksilver, tallow, or wax, injected from the uterine arteries of the mother into the vessels of the placenta, as is confirmed by the most faithful observations; to this add the cessation of the menstrual flux in the mother, which quantity of blood must of necessity be taken up by some other part, viz. the foetus.

§ 831. The remaining unconnected part of the ovum, and likewise the surface of the placenta,

centa, are covered by an external villous and fleecy membrane, full of pores and small vessels, of a reticular fabric, easily lacerable, so as to resemble a fine placenta, and is called the *chorion*. But even this is, in some measure, connected to the surface of the uterus, by very small fleecy vessels, but less and softer than the vessels of the placenta. But then these have inwardly a true solid membrane, spread under them as a foundation, which you may either reckon an inner plate of the *chorion*, or a second distinct covering of the *fœtus*.

§ 832. The innermost coat of the *fœtus*, which is called *amnios*, is a watery pellucid membrane, very rarely spread with any conspicuous vessels, which yet it has had under my observation in an human subject; extremely smooth, and in all parts alike; also extended under the placenta with the former, the surface of which is every way in contact with the waters. With the outer plate of the *chorion* the cellular plate is conjoined.

§ 833. The nourishment of the *fœtus* from the beginning to the end of the conception, is without doubt conveyed to it thro' the umbilical vein. This gathers its roots from the exhaling vessels of the uterus (§ 810.), and has manifest communications by some roots with the umbilical artery, from whence it in part rises, and meeting together in a large trunk, it is twisted in a circular manner thro' a number of folds to a sufficient length, that may allow of a free motion; and in this course it is surrounded with a cellular substance full of

mucus, distinguished by three partitions, and the membrane, which is continued both to the amnios and peritonæum of the foetus; and after forming some protuberances, it enters thro' the navel, in an arch made by a parting of the skin and abdominal muscles, and goes on thro' a proper sinus of the liver (§ 672.), into which the smaller portion of the blood that it conveys is poured thro' the slender ductus venosus, into the vena cava, seated in the posterior fossa of the liver; but the greater part of its blood goes thro' the large hepatic branches, which constantly arise from its sulcus, and remain even in the adult (§ 674.); but it goes thence to the heart by the continuous branches of the vena cava (§ 686.). It may be demanded, whether the circulation be reversed in the liver of the foetus? whether the sinus or left branch of the vena or portarum be not a part of the umbilical vein itself, so as to convey the blood by its branches from the placenta to the cava, while only the right branch (§ 664.) conveys the blood of the mesentery and spleen thro' the liver? and whether this motion is allowable from the different and almost contrary direction of the blood from the umbilical vein, and that brought from the mesentery, since there is no septum to distinguish betwixt the umbilical vein.

§ 834. But this is not all the use of the placenta: for the foetus sends great part of its blood again into the substance thereof, by two large umbilical arteries, which are continued on in the direction of the aorta; and after

ter giving some slender twigs to the femorals, with still smaller arteries into the pelvis, they ascend reflected back with the bladder on each side of it, surrounded with the cellular plate of the peritonæum, with some fibres spreading to them from the bladder and ureter, in which manner they proceed on the outside of the peritonæum into the cord at the navel, in which passing alternately in a streight and contorted course, they form various twistings or windings, somewhat sharper than those of the vein which they play round; in which manner they at last arrive at the placenta, whose substance is entirely made up of their branches, in conjunction with those of their corresponding vein. By these branches the blood seems to pass out through the minute arteries of the placenta into the bibulous veins of the maternal uterus, that after undergoing the action of the lungs by the mother's respiration, it may return again in an improved state to the foetus: for what other reason can be assigned for such large arteries, which carry off above a third part of the blood in the foetus, to the placenta and womb of the mother?

§ 853. But it will perhaps be demanded, whether the foetus is not nourished by the mouth likewise? whether it does not drink of the lymphatic liquor contained in the cavity of the amnios, which is coagulable like the nutritious serum, and in the middle of which the foetus swims? whether this opinion is not in some measure confirmed, by the analogy of chickens, which are under a necessity of being

nourished, from the contents of the egg only; to which add the absence of a navel-string in some foetus's, the quantity of meconium filling the large, and part of the small intestines; the similitude of the liquor found in the cavity of the stomach, to that which fills the amnios, the proportionable decrease of the liquor amnii, as the foetus enlarges; and finally, the glutinous threads which are found continued from the amnios, thro' the mouth and gula, into the stomach of the foetus? again, what are the fountains or springs from whence this lymph of the amnios flows? whether it transcends thro' certain pores from the succulent chorion, which is itself supplied from the uterus? It must be confessed, that these enquiries labour under obscurities on all sides; notwithstanding which, there seems more probability for them than otherwise, since the liquor is of a nutritious kind, derived from the uterus.

§ 836. All the excremental faeces, which are collected in the foetus during the whole time of its residence in the womb, amount to no great quantity, as they are the remains of such thin nutritious juices, percolated thro' the smallest vessels of the uterus. I frequently observe, that the bladder is empty in the foetus, on account of the perpetual warmth with which it is cherished; for in like manner we see, that the external heat in adults will greatly diminish the secretion of urine. However, there is generally some quantity of urine, collected in a very long conical bladder, and the rest is probably transferred thro' the kidneys
of

of the mother. But in the cavity of the intestines, there is collected together a large quantity of a dark green pulp, which may possibly be the remains of the bile, and other exhaling juices, like the feculent remains, which are sometimes left in the other cavities of the body, that are filled with exhaling juices; and such as I have sometimes observed, even in the vaginal coat of the testicle.

§ 837. It may then be demanded, whether there is any allantois? since it is certain, that there passes out from the top of the bladder a duct, which is at first broad, covered by the longitudinal fibres of the bladder, as with a capsule; and afterwards when those fibres have departed from each other, they are continued thin, but hollow, for a considerable way over the umbilical cord, from whence they have been traced by Swammerdam and Dr. Hale, and other eminent anatomists, to their expansion at the placenta, under this denomination? whether this, altho' it be not yet evident in the human species, is not confirmed by the analogy of a brute animal, which have both an urachus, and an allantois? but as for any proper receptacle, continuous with the hollow urachus, it either has not yet been observed with sufficient certainty, or else the experiment has not been often enough repeated, to become general in the human species; for we know, that in the human foetus, the urine is but separated in a very small quantity; but it perhaps may be no improbable conjecture, that some portion of the urine is conveyed to a certain extent into the funiculus umbilicalis, and there be

transfused into the spongy cellular fabric that surrounds it. But then this can take up but a small space, terminating in the funis, and hardly ever seems to reach as far as the placenta, unless in extraordinary cases.

§ 838. In the mean time the foetus (§ 829.) continues to advance in growth, the limbs by degrees sprout from the trunk, under the form of tubercles, and the other out-works of the human fabricature are by degrees beautifully finished, and added to the rest in a manner not here to be at large described, as indeed it has not been as yet by anatomists in general. Thus we see that in the anthropogenesis, the head or encephalon, and its appendages, are first formed and completed; then the viscera of the breast, and afterward the abdomen, and its contents; but lastly, the limbs, with the other extreme parts. But in the thorax of the foetus, we observe a good deal of difference in the organs from those of an adult.

§ 839. The first of these differences is in the thymus, a large conglobate glandule, but of a soft loose texture, composed of a great many lobules or small portions, which are collected together into two larger, and connected one to another by a good deal of cellular substance. It is extended over the bottom of the neck, and thro' a large part of the mediastinum, being altogether filled with a whitish whey-like liquor; but this body being compressed by the repeated expansions of the lungs, is in adults beat together with the pulsations of the subjacent aorta, which enlarges
after

after the birth ; by these means there are at length very little remains of this gland to be seen. It will perhaps be demanded, what is the use of this glandule ; or of its liquor ? We are as yet indeed unacquainted with these particulars ; but we observe also, that all the other glandules of the foetus, more especially of the conglobate kind, do in their bulk greatly exceed those of adults.

§ 840. The cavity of the breast is short in the foetus, and greatly depressed by the enormous bulk of the liver ; the lungs are small in proportion to the heart, and so solid as to sink in water, if they are every way excluded from taking the atmosphere into their spongy substance, in making the experiment. Since therefore the like quantity of blood (§ 292, 297.), which passes the lungs by respiration in adults, cannot be transmitted thro' the unactive lungs of the foetus, who has no respiration ; there are therefore other ways prepared in the foetus, by which the major part of the blood can pass directly into the aorta, from the lower cava and umbilical vein, without entering the lungs. And first the septum betwixt the right and left auricle, conjoining them together, is perforated with a broad oval foramen ; thro' which the blood coming from the abdomen, and a little directed or repelled by the valvular sides of the right auricle, flows in a full stream into the cavity of the left auricle. But it is by degrees that the membranes of each sinus depart from each other, upward and backward, above the oval foramen into the pulmonary sinus, where they are connected on each side
above,

above, by several orders of fibres, which below are palmated or like fingers, so as to close up at first a small part, and afterwards a greater part of this foramen, so as to leave only a small oval portion of it at liberty; which lies previous, betwixt the round margin of the said oval foramen, and the increasing valve, making in the mature foetus, about a fifteenth part of the area or capacity of the mouth of the vena cava.

§ 841. That the blood takes this course in the foetus, and that it does not on the contrary flow from the sinus of the left to that of the right auricle, is evident, from all manner of experiments and observations. For, first, the column of blood in the right sinus, is of all the largest; and as it is the returning one from the whole body, cannot be exceeded by any other; but the left auricle has so much less blood in proportion than that of the right, inasmuch as part of it flows through the duct or canalis arteriosus into the aorta, whence its contents will be much less than that of the right auricle: moreover, the valve of the oval foramen in a mature foetus, is so large, and placed so much to the left of the muscular arch or isthmus (§ 840.), that when it is impelled by the blood from the left side, the valve, like a palat or shutter, closes up the foramen; but being impelled from the right side, it readily gives way so as easily to transmit either blood or flatus.

§ 842. Moreover, there is but a small portion of the same blood, which first entered the right auricle and ventricle of the heart, that takes

takes its course thro' the lungs; for the pulmonary artery, being in the foetus much larger than the aorta, is directly continued into the latter by an open passage, called the ductus arteriosus; which is larger than the light of both the pulmonary branches together, and enters that part of the aorta which comes first in contact with the spine, under its left subclavian branch: by which means it transfers more than half the blood to the descending aorta, which must otherwise have passed thro' the left auricle and ventricle into the ascending branches of the aorta; and this is the reason why the aorta in the foetus is so small at its coming out from the heart. By this mechanism an overcharge of blood is turned off from the lungs, by directing a great part of that fluid in a streight course to the umbilical arteries.

§ 843. As the foetus grows larger, so the uterus increases proportionably; the serpentine arteries of which it is composed, being extended by the impelled blood, and stretched into a more direct course. Thus its thickness continues the same, because the greater quantity of blood and dilation of the arteries and veins, make up for the extenuation of the solid cellular and fibrous substances. But more especially the fundus, or upper part of the womb, increases beyond the rest; so that by dilating the above tubes, these last seem thus to descend from the middle of the uterus, which now by degrees goes out of the pelvis, even as high as the colon and stomach itself, so as to compass all the abdominal viscera,

more especially the bladder and rectum. During this whole time of the uterine gestation, the os tincae is never perfectly closed or shut together, but only stopped up and defended from the air by thick mucus from the sinuses, and perhaps from the vesicles, which are seated in the cervix uteri. Moreover, the cervix or neck of the womb itself, yields to the extension of its body; so as to become perfectly short, and form a broad flat opening, of no length; which, towards the time of delivery, is always more or less relaxed and gaping. As these matters advance, the foetus, which in the first months had no certain situation, being now grown to a considerable bulk, is about the middle of the time of gestation, folded together into a globe, in such a manner that the head lies betwixt the knees; and being the heavier part, it subsides by degrees, more and more towards the cervix uteri.

§ 844. This alteration and advancement of the foetus, excites at first uncertain commotions, by which the sides of the irritated uterus endeavour to disengage themselves; and at length, towards the conclusion of the ninth solar month, when both the weight and restlessness of the foetus in often kicking the womb, become now intolerable, the head of the foetus is by the re-action of the uterus and abomen, impacted into the bowl of the pelvis, so as to give the mother great uneasiness, as if a quantity of faeces were collected for exclusion in the rectum; in consequence of which

which pain, the mother is obliged to throw or strain towards delivery.

§ 845. The tenesmus thus increasing till it is no longer tolerable, the mother uses all her efforts by very deep inspirations, which press downwards the uterus and viscera of the abdomen (§ 745.); and at the same time the womb itself, by its contractile vital force, now increased by the stimulus, constricts itself so powerfully about the foetus, as sometimes to exclude it, without further efforts from the mother. Here then the amnios, filled-out with the waters, is first protruded vertically, before the head of the foetus, so as to dilate the os internum uteri; in which, the membranes being by degrees extenuated and dilated, easily break, and pour out their waters, which lubricate the passages, and relax all the parts of the vagina. The naked head of the foetus now presents, naturally with the face to the os sacrum; directed that way by its weight: and being urged forward, like a wedge or cone it further dilates the os uteri; till at length, by the more powerful efforts of the mother, which often loosen the bones of the pubis in young women, the head is thrust out through the distractile vagina, with intolerable pain to the mother, and an universal tremor of body; and if none of the bones of the pelvis happen to press unequally, the infant easily advances, and is soon delivered into the world.

§ 846. The placenta or after-burthen of the foetus, connected with the fundus uteri (§ 810.) is, in the next place, separated from the
6 womb,

womb, without much difficulty in a mature birth, partly by the weaker throes of the mother, and partly by the extracting force of the deliverer; by which the fleecy or villous surface of the placenta being withdrawn from that of the womb, is immediately followed with a considerable flow of blood; and thus is the mother delivered from the secundines or after-birth. The umbilical cord of the foetus is next tied with a ligature before it is cut off; for it cannot be left open, without danger of a fatal hæmorrhage. Thus the umbilical vein is deprived or cut off from all the supplies of blood which it used to receive, and at the same time an insuperable obstacle is opposed to the exportation, that was made by the arteries of the same name.

§ 847. The uterus, which hitherto had been distended beyond imagination, now contracts itself, by the elastic power of its fibres; (§ 804.) so suddenly and powerfully, as often to catch and embarrass the hand of the deliverer, and frequently retain the placenta, if it be not soon loosened and withdrawn. By this contraction of the womb, the bleeding vessels are compressed, no less than by the contraction of their own coats; whence the large quantity of blood that was collected in the uterine substance abundantly flows out, under the denomination of the lochia; at first a mere gore, but afterwards a purple colour changes by degrees to that of the yellow serum; and as the openings of the vessels more contract themselves, they at length become of a whitish or wheyish

wheyish complexion: and then, the ample wound or excoriation of the uterus soon recovers a new epithelium or cuticle, and shrinks up to a bulk not much exceeding that of the primitive virgin uterus.

§ 848. But after two or three days are elapsed from the birth, when the lochial discharge has almost spent itself, the breasts begin to swell considerably, and their ducts, which in the time of gestation often distil a little thin serum from the nipple, become now very turgid, with a sweet liquor; which is at first thin or like whey, but is soon after followed by the thicker chyle itself, not much altered, under the denomination of milk; namely, a white, sweetish and thick liquor, very much resembling that of the chyle, and replete with an essential salt, like that of sugar, which spontaneously turns sour; it has also a volatile and somewhat odorous vapour, a good deal of fat or oily parts, a larger portion of a white crassamentum or cheesy curd, and still more of a diluting water; and again in the crassamentum, are contained parts of a more earthy, alcalescent or animal nature. But when the chyle is once changed into serum, by fasting six or more hours after a meal, the milk becomes brackish, alcalescent, and displeasing to the infant. As the chyle, so the milk frequently retains the nature of the aliments and medicines taken into the stomach. The cause of this increased secretion in the breasts, seems owing to the revolution, in consequence of the plentiful uterine secretion being suppressed, by which the foetus was nourished;

rished; in the same manner as a diarrhæa is suppressed by increasing the perspiration, or the reverse. For it has been observed, that true milk will sometimes make its way thro' other parts, besides the breasts, and escape through wounds, &c. but the inosculation betwixt the mammary and epigastric arteries, though true, are so small, that they can have but a very little share in this account.

§ 849. The breasts are made up with a very large quantity of soft surrounding cellular fat, of a white colour; and conglomerate glandules, of a convex figure, assembled into bunches somewhat round and hard, of a reddish blue colour, outwardly surrounded and connected together by a firm web of the cellular substance. To these glandules a great number of blood-vessels are distributed from the internal mammaries, from the external vessels of the thorax, and sometimes from those of the shoulders, all which inosculate together around the nipple. The nerves of this conglomerate gland are both large and numerous, like those of the more sensible cutaneous parts, being derived from the intercostals.

§ 850. From the middle of the glandules of the breast, an infinite number of small ducts or roots arise, very slender, soft, white, and dilatable, which run together into larger, from all sides to the middle of the nipple, which they perforate round its margin, in a circular figure, after emerging through the root of the said *papilla* or nipple; for by this denomination we call a cavernous or spongy protuberant body,

body, into which the blood may pass out from its vessels, so as to cause a kind of turgescence or erection, with a somewhat similar sensation, as in the clitoris or penis. Through this papilla open about twenty or more of the excretory ducts from the breast, called lactiferous, none of which inosculate or join with the other, but are greatly contracted at their opening in the nipple, to what they were in the breast; and these in a loose or flacid state of the nipple, are compressed, wrinkled, and collapsed together; but when the nipple is distended by suckling, or any kind of titillation, they become streight and open, with patulent mouths, lurking betwixt the wrinkles or incisures of the cutis and cuticula. This papilla or nipple is surrounded by a circle, planted with sebaceous small glandules, which defend the tender skin against the repeated attrition and saliva of the sucking infant.

§. 851. Thus the infant is naturally provided with its first food, which by instinct it well knows how to receive, although it is as yet a stranger to all the other offices of human life. It is remarkable with how much fervency the young guest causes the nipple to swell by gentle vellications; the lips are pressed close to the breast, that no air may enter betwixt, at the same time the inspiration is deep, and a space formed in the back part of the mouth, in which the air is more dilated or rarified; and thus, by the pressure of the external air, joined with that from the lips of the infant, the milk is urged from the breast through the

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nipple, in which it would otherwise be collected in so great a quantity, as sometimes to distil spontaneously, from the force of the circulation; whence it is in this manner more easily drawn, as nourishment, by the infant.

The first milk, which is like whey, termed colostræ, loosens the tender bowels and purges out the meconium (§. 836.), to the great advantage of the infant. Yet it is also observable, the lactiferous ducts are so open, that when the nipples of the breast are distended by titillation, and a greater quantity of blood sent into the breasts, they have yielded milk to the sucking infant, even from virgins, sometimes from old women, and rarely from the breasts of men.

§. 852. But great changes now happen to the little new inhabitant of our world; and first, its dormant and unactive uterine state immediately changes, in the respiration, which it endeavours to exert, even before it is well set at liberty from the vagina of the mother, being probably excited thereto from the pain or anguish it feels by the various agitations of the deliverer, who is immediately saluted by its cries. At first, therefore, a portion of the air is admitted into the lungs, which are as yet small and full of moist vapours, but being dilated from the air, change from a small dense body, sinking even in salt water, into a light spongy floating fabric, extended to a considerable bulk, with air. Now therefore, the blood passes more easily into the enlarged and loose fabric of the lungs (§. 292.); in consequence of which, a large portion of the blood that

that went before from the pulmonary artery, thro' the canalis arteriosus, into the aorta, goes now into and through the lungs themselves, by the other branches of the said pulmonary artery. And so much the more is the arterial duct or canal deserted, inasmuch as there is made a new obstacle to the descent of the blood into the abdomen, from the ligature of the umbilical arteries; whence the blood of the descending aorta cannot thus go to the lower parts, but by the same force, with which it dilates, all the arteries of the pelvis and lower extremities. Finally, as the lungs now receive more blood, so the aorta itself receives a greater quantity, and with greater force likewise from the heart; whereupon the intermediate canal, betwixt the protuberant part of the aorta and pulmonary artery, closes up or shrinks to such a degree, that, in adults, it is not only an empty ligament, but likewise of very little length. This course of the blood, therefore, is soon abolished, or shut up commonly in about the compass of a year.

§. 853. In the like manner also, the foramen ovale is, from the same causes, gradually closed up. For when the way is rendered more free and pervious into the lungs, it will likewise be more free into the right side of the heart; whence the blood, both of the ascending and descending cava, will flow thither more plentifully, as it is invited by the more lax pulmonary artery, into which it will rather move on, than through the oblique narrow foramen of the septum. Again, the umbilical vein, being now almost

destitute of any supply with blood from the ligature of the navel (§. 846.), less blood will from thence flow into the lower cava, and consequently the pressure, on the right side, against the oval foramen will be diminished, by which means the blood of the upper cava, being turned off by the isthmus, will be scarce able to penetrate the obliquity of the foramen ovale. Thence again, as more blood is derived through the lungs into the left sinus and auricle, its greater dilatation and extension will strain the little horns of the oval valve, so as to draw up and press the valve, together with the isthmus, whereby it is extended so far, as wholly to shut up the opening in the mature infant, while, at the same time, the blood, within the left sinus, props up the said valve, so as to sustain the impulse of the blood, on the other side, within the right sinus. Thus the foramen ovale closes up by degrees, as the upper margin of the valve forms a concretion to the posterior face of the isthmus. But this is performed very slowly, insomuch, that frequently, in an advanced age, there will be some small aperture or tube still remaining; and where there is none of this tube, yet there are the remains of one, as a kind of sinus, hollow to the left side, that makes a tube opening upward to the right side, and blind or closed to the left.

§. 854. The umbilical vein, being deprived of blood, soon closes up. The blood of the vena portarum, having no opposition from that which formerly flowed through the umbilical vein, occupies the left sinus and curve of the
umbi-

umbilical fossa (§. 674.), and sends its blood through those branches, by which that of the umbilical vein before passed. Thence the ductus venosus, being neglected, shrinks up and closes, by the new compressure which the descending diaphragm makes, upon the liver by inspiration; and by which the left lobe is pressed towards the lobule, and perhaps too from the obtuse angle which the venal duct makes with the left sinus of the vena portarum; for it is certainly first closed in that part which lies next the vena portarum.

§. 855. The umbilical arteries are also closed up from the same causes, as other arteries usually are after a ligature, when some of the blood, being, at the same time, compacted into a polypus, fills up the blind void part, while the other blood, flowing above, whose impulse was sustained by the resisting membranes, spreads itself through the adjacent less resisting branches, which are thereby rendered more open or diverging. Nor do I think we ought to neglect the force of the abdominal muscles towards this effect, by which those arteries are compressed against the full abdomen in each respiration; and again, the very acute angle, in which the umbilicalis goes off from the iliac artery, now becomes a curve, by descending with the sides of the bladder, and is then directly extended into an acute fold, which the thighs make with the body of the foetus. Thus the capacity of these arteries is soon shut up, leaving only a small tube, that gives passage into two or three arteries of the bladder. The urachus, be-

ing likewise a very thin tube, extended perpendicularly upward from the bladder, is, therefore, easily closed up; so that the contents of the bladder make no endeavours to pass that way, finding a ready outlet by the descending urethra.

§. 856. From the like causes the bulk of the liver itself is lessened, and, by degrees, contracts itself within the capacity of the ribs; in the mean time the intestina crassa, from the slender condition in which they are observed in the foetus, dilate to a considerable diameter, and the stomach itself is gradually elongated; the large convexity of the cæcum forms itself by the force of the faces, pressing perpendicularly downward to the right side of the vermicular appendix; and the lower limbs are likewise considerably enlarged by the return of the blood, sent back from the umbilical arteries now tied; and, by degrees, all the other changes are made, by which a foetus insensibly advances to the nature and perfection of an adult person.

§. 857. It will, perhaps, be demanded, by what cause the parts of the foetus are thus successively built up? whether this be the employment of the mind or *anima*? we answer, that this does not seem an adequate cause, being both ignorant of herself, and incapable of foreseeing the future ends or purposes, for which the several organs and their actions are to be employed, by a just mechanism of the several members in the foetus — Or it will be queried, whether the first rudiments, or filaments, being contained either in the ovum of the mother,
or

or in the animalcule of the male semen, are only afterwards displayed, and filled out, by a more plentiful flow of juices? for this, we have neither any such delineation demonstrable in the female ovum (§. 826.), nor in the animalcule of the male semen (§. 788.).—Or whether in consequence of the power of attraction, by which nature performs all her other operations, the viscid liquor of the ovum, altered by the semen, does not first run together into a thread, which, under unknown circumstances, increases to a web of fibres, those into membranes, membranes into vessels, and all these again into muscles, which, at length, condense into bones, and make all the limbs of the body? we must give it as our opinion, that this seems to be the most probable. But you will say, what can be the wise director of such a constant, such a curious, and such a just structure, in so great a variety of parts, and to such a number of particular uses? we answer, that it is doubtless the same ever acting and permanent laws of the wise creator, by which freezing spicula, chrystals of salts, the particles of mineral ores, the earthy globules of stones, and the sandy glebes of gems or chrystals, are so elegantly or geometrically constructed; by which the fine dust of mosses, and filaments of the flax or cotton, or the jelly of the fungous tribes, with the different juices of plants and their parts, are variously modulated: the same power, under various circumstances, certainly ordains the unorganised parts of suitable matter into the tubular webs and fibres of vegetables, the glue

of the more simple insect and shell-animals, and the earthy stamina of the blood and finer juices of the more perfect animals, into such various filaments, cellular webs, and vascular membranes, &c. as can be only the effect of definite laws, operating on the same kind of suitable matter, and under a variety of circumstances or conditions perfectly similiar. Need we go farther for a proof of this, than the successive germination of the viscera and limbs in a foetus; in which, as in the polype, we see the upper and lower extremities sprout insensibly, not as threads, but equally, from tubercles, which (like trees) only grow in length, in proportion as they increase in thickness, and are unequally dilated? consider, if the successive formation of the heart, out of a single tube, in a foetus or chick, afterwards curiously complicated (§. 788.), and then, by degrees, shielded within a cradle of the ribs and breast, be not enough to turn the balance in this enquiry; more especially if you join a close attention to the series of the growth in plants, in polype insects, in chickens of the feathered tribe, and in the foetusses of our own species, leisurely compared together?—Whether the time of gestation and delivery are confined to a limited space? generally so as hardly ever to exceed the eleventh, or to fall within the beginning of the sixth month, and the foetus survive, as we learn by repeated observations, collected from all quarters.—Whether the blemishes or uterine deformities of the foetus shew any constructive power or faculty of the mind over the body?

we neither know of any passages, by which the mind of the mother can direct its operation to the body of the foetus, nor of any matter it can send to effect such a power, nor, in herself, has she any impulsive power, or any conscientious knowledge of her own or the infant's being, much less any constructive wisdom or power (§. 562.): and in short, most of the instances are either trifling, unjustly related, or else mere superficial cutaneous affections, such as may arise from some small external injury or stimulus, which the weak mother afterwards ascribes to some fright or notable accident, she can recollect to happen in her pregnancy. But then, from whence arise monsters? whether are they from a commixture of foetuses, half perfect? or were they originally formed, as we see them excluded? we are rather persuaded to believe the former, from the various cohesions observed in the hearts of ill-formed foetuses, which is a part not to be injured without fatal consequences; and from the two intestinal tracts, cohering together upwards with distinct tubes, throughout their course in double-bodied foetuses, and in a very constant regular order: to which add the new and unusual parts formed to some particular uses of a monstrous foetus, and the double or superfluous parts, which are single in a well-formed foetus. —Whether superfœtation be possible, when the closure of the os uteri, the shortness of the pendulous tubes to embrace the ovary, and the previous fullness of the womb, with its ovum, are repugnant? that superfœtation may happen
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in the two first months, is certain, while the womb is, in a manner, but half full in its forepart; whence a withered skeleton or clay-like foetus is sometimes first excluded; and an healthy sound infant is thus brought into the world some weeks or months after a former, that continues healthy and living. What are the bounds of fecundity in the human species? for a woman to bring four at a birth, is very rare; though there are two or three instances recorded of five.--- What are the causes of the *pica*, longings or vitiated appetites of pregnant women? one cause may be the nausea, excited in the sensitive stomach, by the absorbed semen of the male spreading, in the first months, with the blood (§ 790.): afterwards the same nervous organ may be variously affected by compressure from the womb, and the retained menses. Other causes may be added, from an idle imagination, fruitful in foul ideas. [Whether the corpus luteum is full of succulent organic particles, which combine with others of the same kind in the virile semen, to form a new animal? but the corpus luteum is not a cause, but an effect of impregnation; since it is not to be found in the virgin ova, only it is visible after the first conception, nor are the juices thereof different from those in other parts of the body.]

NOSOLOG Y:

OR,

BRIEF DIRECTIONS

FOR THE

KNOWLEDGE and CURE

OF THE

Principal DISEASES, incident to the
HUMAN BODY, before described.

§. I. **F**ROM the physiological accounts we have before given of the human body, it appears to have been originally a gelatinous or unorganized liquid, lodged in the seminal fluids of the male, and within the female ovum; in which last, by that mutual power of accession, seen in all nature, which is directed by the hand of omnipotency, the said fluids, by incubation in the ovary and womb, do there, by a gradually increased cohesion, shoot out into a
2 web

web of elastic threads (§. 16.), which, by degrees, is formed, one part into a vascular and nervous system, successively ramified or extended from their two sources, the heart and ~~encephalon~~ cephalon; and then the other part, keeping its primitive cobweb-like fabric, continues interspersed amongst the former as a cement, called cellular substance, to sustain and keep them within due bounds, without hindering their respective actions or motions. Since then it is evident, that the animal elements, which are a subtle cretaceous earth and glue, or jelly, run first into filaments, several of which, by some unknown mechanisms (§. 6.), acquire a muscular or motive faculty, from whence all the organical fluids of combined globules, either pellucid in the nerves and lymphatics, or red in the blood-vessels, are subsequently formed: it is from thence evident, that the basis of pathology, no less than that of physiology, must be derived from the prior and most simple solids, and their combinations; to the diseased or healthy state of which, the fluids, which they make and move, are universally conformable. But we except from hence the effects of those contagious diseases, which nestle and increase in some of the more viscid and almost stagnant juices, secreted from the blood; such as the variolous and cutaneous exanthemata, from an infection or corruption of the ærial mucus and cutaneous liniment; with the mucilages of the urinary and other parts, from venereal infections; and that of the villous coat of the gula and stomach, from the bites of mad

mad animals, &c. Here you may consult the remarks at the end of lect. II. p. 22. as necessary preliminaries.

§. 2. All disease then is some vice, either in the structure or actions of the animal vessels, and their contained juices, reciprocally on each other, and so may be properly distinguished into universal, affecting the whole habit; or local, confined more or less to particular parts: tho' properly, in the human body, which, like a circle, has, in all parts, a communication or consent (§. 555.), there is no universal disease that affects the whole system equally alike, nor any one local disease that does not proportionably more or less affect the whole body. Otherwise diseases may be usefully divided, according to the principal seats or residences of their nearer and efficient causes, which are always either a deficiency or an excess of motion in the solids, from which the motion, quantity, and quality of the circulating fluids are soon after vitiated, in such proportions as manifestly call for physical aid.

§. 3. We have seen, that all the solids of the human body are either (1.) *consistent*, for the configuration, support and defence of the rest, as in the bones, cartilages, cellular substance, callous or scaly integuments, &c. which, serving to give due bounds and resistances to the rest, are, in those respects, as important as if they exerted a vital action. Or (2.) they are *motive*, (§. 408.) i. e. able to contract and elongate themselves alternately by a vital, nervous force, either voluntary or spontaneous. A defect

fect in either of these motive or resisting powers of the solids, is properly called a laxity or weakness of the fibres, membranes, and vessels.*

The first we call a *tonical weakness*, as it is a diminution of the cohesion, tone or tensity, in which all the solid threads of an animal are maintained to act harmoniously, and produce health: and the last we call a *vital weakness*, as it comes from a defect in the motive or muscular contractions of the fibres, membranes, vessels, and viscera. This last, when habitual, is for the most part, a consequence of the first, which makes the removal of it so tedious and difficult in chronical diseases; but when it is sudden, from hæmorrhages, a diabetes, a diarrhoe, or some profuse sweat, 'tis more easily cured.

2. This is a very necessary distinction in practice, because in the last cases, you may use freely chalybiates, bark, cold-bathing, aluminous and vitriolic waters, or other mere astringents, with the most speedy and successful events: whereas in the nervous or vital weakness, if used alone, without nervous stimulants, they would so far increase the dead vis tonica over the vis motiva or vitalis, as to destroy the predominancy, which the last ought to have in the balance with the former, whenever a small increase of power by the nerves, from the will or outward stimulus, shall accede to put the same upon a vital contraction. From a neglect of this, we daily see dropries, jaundice, asthma's, obstructions of the glands, mesentery spleen, liver, womb, and other viscera, induced,
for

for want of joining proper exercise and stimulants at the same time, or together with the mere astringents; which ought, on that account, to be always mixed with aromatics, bitters, and nervous or hysterical drugs, for the cure of such habitual debilities, as will otherwise soon induce a cachexy and wasting in weak children, girls, and idle women; in hard-drinking or unactive men; or in weakness after fevers, hæmorrhages, long purging, &c.

R E M A R K

* That we may ascribe due honour to our medical ancestors, who have first opened the way to this solid, simple and unchangeable basis, upon a due knowledge and discrimination of the nature, causes, and effects of which all just theory and practise in physic is derived, give us leave to transcribe a few words from our old Harveian friend and contemporary, professor GLISSON, in his anatomical tracts, wrote near a century past, entitled, *De ventriculo, &c.* p. 138 & seq. cap. V. *de fibris. Ad fibrarum usum, & actiones, spectant earum robur, irritabilitas, & causæ irritantes. Constitutio fibræ est vel (1.) insita, & organica ex partium continuitate; vel (2.) influxa; quæ, vel vitalis, vel animalis.—Tensibilitas ad constitutionem requiritur; ut apte extendatur & contrahatur: flexibilitas, ne rigescat ne diffluat.—Inde partes solutæ ab invicem resiliant, & vulnera difficilimè reuniantur.—Constitutio fibrarum influxa, si deficiat vitalis, vis & robur illicò in typhymia languet; aliter afficiatur in febribus. Si intercipiatur influxus animalis, ut in paralyti stupent fibræ, tum animales tum naturales: omnes enim sensu tactus gaudunt, omnesque, (exceptis illis quæ ad pulsum & respirationem fasciunt) interdormiendum otio fruunter. Actio ergo fibræ, duplex est; contractio & relaxatio. Fibra sibi permissa, nullo stimulo*

stimulo five irritamento laceffita, quieti se tradit; ut in somno. Fibrae enervatae, ut in paralyfi afficiuntur; item debilitatae, non laxatae, quietem affectant.—Passio fibræ organica. in distentione quadam constitit partium; ita enim partitur, etiam ab externa causa. Simplex autem fibra se ipsum secundum longitudinem distendere nequeat. Distentio partes distrabit, cui fibra ipsa renititur. Robur animale pendet in fluxum a cerebro: uti languor vitalis a penuria aut depravato influxu sanguinis & spiri'um. Inter ea justa proportionis latitudo sit, modo major, modo minor; intra quam alterutrum absque notabili læsione alterum excedat, &c.—Further on, in this and the next chapter, of the strength and irritability of fibres, he advances many other useful particulars, which, with the preceding, doubtless furnished the materials for Bellini, Baglivi, Hoffman, and our great Boerhaave, to work into more extended and elegant systems, equally sound and useful, both in theory and practise. Whether, or how far, old Glisson was obliged to his friend Dr. Harvey in these hints, which are almost of equal importance to physic with the circulation itself, we must not presume to say.

§ 4. The *tonical weakness*, or laxity of the solids (§. 3.), shows itself by various effects, according to its degree, and as it is extended, either only to some, or to all parts of the body, or as it hath been of a longer or shorter duration. If the complaint be recent, you have generally a begun *cacochylia* or indigestion; whence heart-burn, colics, flatus, costiveness, hysterics, &c. afterwards the cellular fabric too easily flags or subsides from sustaining the least vessels; whence the blood becomes loose, pale, and stagnant in them; so as to cause a
livid

livid swelling under the eyes, pale tumid lips, swelled ancles, &c. And if the relaxing causes continue a longer time, they affect even the least cellular strata, that connect the medullary fibres of the encephalon and nerves one to another; whence the nerves, for want of due resistance and support, easily become overfilled by slight impulsive causes or passions of the mind, and likewise return too strong a report from external objects again to the mind, in which consists the nature of tenerity, or weak and tender nerves. This disorder seen now almost every day, more especially in those who naturally, or by habit, have acquired a looseness of the cellular fabric (Vol. I. p. 28, ult.), and likewise too great a dilatation of the nerves internally, by repeated and violent efforts of the mind; such as young children, unactive delicate women, studious and sedentary men, &c. increased by too long indulgence in the warm bed, warm sippings of tea, coffee, &c. or overstrainings of the vessels and nerves beyond their contractile or recoverable tone, by over-early or excessive venery, hard-drinking, fevers, &c.

2. From these causes a weakened habit is generally brought on, and spread by degrees, especially in those whose first stamina or shooting threats (§. 16.) were originally formed with too weak a cohesion, from feeble seminal fluids, as is probably now more commonly the fault than ever before in the world: but having, from any or all of these causes, once gained a footing, it spreads, from the chylificative, to the sanguineous and serous systems, and, by de-

grees, through the nervous, where the disorder, lying out of the reach of medicines, rarely admits of more than a temporary palliation, or such a cure as will easily be followed with a relapse.

§ 5. This laxity, although in the whole habit, commonly shows itself more in one system or organ than in another; according as some of them have either naturally, hereditary or abusively acquired a greater disposition to weakness. Hence, (1.) in the first passages, you have a cacochylia or indigestion, which, according to the nature of the food or drink, is either a sour, an oily-rancid, a heavy-slime, or a putrid-alkaline; whence heart-burns or oppressions, nausea, ructus, &c. — (2.) In the second passages, betwixt the heart and encephalon, throughout the vascular system (if the first passages should have performed their office well) this debility occasions a plethora, the most fruitful mother of other diseases, especially among those who feed with English luxury; whence a propensity to acute and epidemic fevers, inflammations, &c. But if the former (1.) has also joined itself in company, you have then a cachexia of all the solid, vascular and cellular systems, and a cachochymia of the blood and other juices thence separated; whence a propensity to slow fevers, obstructions or concretions of the gelatinous humours in such of the least vessels, where they have the slowest motion (§. 134.); thence a corruptive dissolution of the organical or globular humours; such as the blood, serum, lymph, and, perhaps, in
4 some

some cases, even of the nervous juice: hence dropfies, scurvies, and consumptive wastings (that are not purulent, from ulcerated viscera) by sweats, urine, fluxes, &c. (3.) The animal or nervous system, produced, by mechanical fabrication, from the encephalon (§. 778 and 838.) may lastly be more especially relaxed or debilitated, as we said before (§. 4.), either while the two antecedent systems, which supply it, remain tolerably firm, or are conjunctly vitiated; whence weakness of the muscular powers, as well in the arteries and viscera, as in the muscles properly so called, low spiritedness, chilliness, tremblings, pusillanimity, and hysterical disorders, which differ in their degrees and seats, or extensions. Thus morbid solids generate vitiated fluids; and as a cacochylia or indigestion, in the first passages, cannot well be corrected in the second, it there breeds a cachexia and cacochymia, which also soon follow from a mere plethora; for if the redundancy, first collected into the cellular fabric and least vessels, by inactivity and over feeding, be, by sudden heat, hard-drinking, or violent exercise, urged into the larger trunks, it dilates them beyond their tone, whence a present hæmorrhage or ecchymosis, and a begun phthisis soon ensue; or more slowly come on a future dropfy, scurvy, or asthma convulsive and phlegmatic, &c. from their inertia on the blood. We have now seen, how diseases often rise one from another in a chain, by a debility of the solids too slowly moving, or digesting their fluids. Let us now speak a word upon the best

methods of relieving them, and then proceed to their opposites, which arise from too great density of the solids, exerting either a too great spring, or a too powerful muscular action on the blood, and its juices in the arteries, lungs, and other viscera, which over compact the humours, so that they too easily acquire the state of a solid, by cohering with, what we call, a phlogistic, or inflammatory tenacity.

§. 6. The said laxity or debility of the solids may be relieved or cured by the use of aperients, restringents, and corroborants. (1.) Let the first passages be freed of their load, not by a strong purge, that will disturb the nervous system, but so small a dose of *infus. sen. cum man. vel sal. Glaub.* or a little bolus ex *Pulv. Rhei & Cal.* that will only clear out the intestinal contents. (2.) Let the diet be very small in quantity, light, and of good juice, that will easily digest; as custards, bread-puddings with eggs, boiled fish, or white fleshed poultry; the meal to be only one thing or dish, with light French-bread, and the drink to be as scanty as possible, of sound red wine and water, p. e. avoiding tea, coffee, or any drinking betwixt meals; and let no fat, oil, or butter be eat. (3.) Let the whole body, as soon as the patient arises, be plunged in cold water, wiped dry, and well rubbed with a rough flannel, blanket, or a flesh-brush, with all imaginable expedition; and then let riding or walking be practised, 'till they begin to tire, or to sweat. (4.) Let the bed-time be reduced gradually to five hours, or less, if the patient does
not

not sleep in it ; and let the air be high or hilly, on a chalk or gravel, if possible, and the clothing or apparel be gradually extenuated or lightened during the summer, and accustomed to be afterwards worn thin, as discretion and the weather-clock may direct, all the ensuing winter and after. (5.) Never use milk, soups, beer, or other liquors made *hot*, in the common course of diet ; for this is præternatural to man, as well as to all other animals, and, by relaxing the nerves of the stomach, heart, diaphragm, and other adjacent viscera, is productive of numerous diseases, in those who have them already weak ; much less scalding tea, which many drink hot enough to fetch the skin off a delicate finger. But if tea be strong, and let stand 'till near cold, 'tis a salutary beverage for a stomach that is not sour, which cannot be said of coffee, that is only fit for a relief to debauchees, or an over meal. (6.) Let restringents and corroborants be used conjunctly in small, and often repeated doses, increasing the quantity gradually, and leaving off in the same manner, viz. bark chalibiats, rhub. | pulv. è bol. c. | spec. aromat. | elix. vitr. | infus. cort. cum sp. acido minerali, vel alcalino volatili, pro re nata, &c. Only observe, never to be over-free in the use of chalibiats, bark, or other astringents alone ; especially at first, and in weak or cold diseases : because, as they increase the inertia and cohesion of the solids and fluids, over their muscular vis vitalis nervosa, they will thus confirm, rather than cure the disease ; unless the latter powers be also pro-

portionably excited, by the conjunct use of nervous stimulants and exercise.

2. However, there are some cases, where they are best used very sparingly, and without stimulants, as when an hæmopthoe, a profusion of the menses, night-sweats, &c. come from debility; or when the organic texture and consistence of the blood and least vessels are only required to be kept up, as in most of the contagious fevers, after the height of inflammatory ones, in the putrid alkaline scurvy, in purulent hectic, &c. But for œdematous debilities, which come after fevers, or chronic distempers, with epilepsies or foolishness from the same cause, and colliquative discharges from relaxed emunctories, weak perspiration, and hysteric complaints, with rickets in children; 'tis always best to join aromatic and bitter stimulants, together with such drugs as are restraining. Thus operating conjunctly, by tightening up the vessels, and exciting the vital or muscular forces of the heart and arteries at the same time they gradually cause, and increase a due degree of plethora, which, by urging the blood most, where it is least resisted, will overcome uterine or other obstructions. On the other hand a too hasty and free use of restringents at the first, without any preparatives or evacuations, and revulsions, will often sadly increase the hæmopthoe, menstrual or other excessive fluxes, which they are designed to suppress.

§. 7. From §. 5. we may understand, how intermittents arise from cold ropy viscidities, collected in the first and second passages

sages debilitated ; and why they have often a strange anomalous appearance, when, by neglect or ill-treatment, the febrile colluvies has extended into the nervous system. How medicines, which have a strong absterfive bitterness, with a powerful restringency, dislodge, attenuate, and expel the said matter, either insensibly by perspiration, or visibly by the urine ; provided it lies within the sanguineous system, as you may know by a lateritious urine, declaring for a safe use of the bark ; otherwise if it lies in the lymphatic or nervous system, you will not cure, but lock it up by the bark, which acts chiefly, by contracting and invigorating the blood-vessels, into which the aguish matter must be first returned, by a few fits and concussions of the fever, helped with a vomit, or a purge or two of rhab. and cal. before you attack it with the bark. Hence the reason, why saline draughts, camph. and other attenuants, often effect, what bark will not, in some stubborn agues, &c.

§. 8. The other source of diseases, opposite to laxity (§. 5. ult.), lies in too great a density or compaction of the solid fibres, membranes, vessels, and humours ; so that those, which are consistent (§. 3.), become *rigid* or unpliant to the vital forces of the heart and nerves, which they ought easily to yield to ; and from thence the muscular or moving fibres, and the least vessels, closing up their organic fabric too soon, degenerate into mere tendinous, ligamentary, or often bony threads. This *Rigidity* or density does not generally call for our aid, before a

certain age, as does the former, in mankind at least. However, it may come on too hastily, or prevail too much for the crasis of the fluids, either in the whole habit, or in certain organs only; by a continuance or repeated alternations of excessive heat and cold, joined to a parental disposition in the primitive stamina, or first component threads (Physiol. §. 16.); to which add abuses from astringents, spiritous liquors, much labour, in an hot sun, or by great fires, and repeated diary or topical inflammations, with respect to certain organs; for any part of the body, that has been more subject to inflammation, or to labour than the rest, becomes thereby more dense or rigid. In consequence of these, and the like causes, young folks often shoot up, gain their acme, and expire too soon; as in the late extraordinary Cantabrigian virile infant. Or again, the thinnest parts of the fluids, and more watry glue of the solids, being thus too much expended by the more violent oscillations and expulsive forces of the arterial and cellular systems, the former gain such an impervious lentor or tenacity of their parts, as we call *phlogistic*; because, by cohering more strongly together, and to the vessels, they thus generate a greater heat from the circulating triture or motion, and are thence apt to hesitate in their way, without extending so far as the least ducts and vessels, which, for health, they ought to pervade: from whence we have a dry, hot, and scurfy skin; a costiveness, with high-coloured and strong-smelling urine, very salt, and but little in quantity; a deep or laborious

rious breathing, with an hard and small pulse ; from all which, the person is liable to frequent, painful, and inflammatory fevers or stubborn inflammatory disorders, in some parts or other, induced even from slight causes. Such a dense disposition of the vessels in the viscera, no less than in the muscles, renders them liable to be cramped (Vol. I. p. 43.), either by nervous consent, or from those passions of the mind, which cause a more powerful vital constriction in them ; after which they ought naturally to relax, only this over-dense, tonical, or automatic, and springy force, will keep them for a long time shut up. Hence, from frights, vexations, or pains, will arise a convulsive jaundice in the liver ; hiccups or pains in the stomach, or suppressed menses in the womb ; an asthma in the lungs ; a suppressed perspiration and fevers by the skin, or hysterical and watry urines by the kidneys ; and sometimes, when the intestines are lax or open, and the other emunctories cramped, a flux ensues from the former analogous to the hysterical diabetes, in both which is lost a great part of the finest nervous lymph, that should supply the encephalon.

§. 9. Here every thing will be useful to a cure, forbid in the opposite cases (§. 5.) ; the warm-bath, warm liquors, oils, mucilages, honeys, soaps, creams, whey, oat or barley gruels, nourishing or retentive clysters, a warm and moist air, much rest, sleep, &c. A good emollient and relaxing drink is an almond emulsion in barley water, well charged with honey and nitre ; and a diet almost entirely of milk

milk or whey, creams, chocolates, sagoë, sallow, &c. and in all the organical cramps of the viscera abovementioned, as well as in universal and febrile strictures, bleeding with papaverines, and often a blister to the next part, will have their good effects.

§. 10. This said inertia, or rigidity of the solids (§. 8.), gradually advancing from our infancy, brings on us, at last, all the symptoms and appearances of old age, and terminates itself by mere vital debility, which we call a natural death ; because the powers of the heart and encephalon are now no longer able to surmount the inertia of the solids, by this time loaded with too great a quantity of earth, deprived of the more thin and fluxile parts of their glue, and changed from their motive or organical fabric, (whether muscular or vascular) into that of solid or over-resisting threads, in some parts often as tough as ligaments, or hard as bones. Thus the arterial system too much resists the heart itself, more callous and insensible to the stimulus of the blood ; the lungs make a greater resistance to the incumbent air ; and the craticle of the thorax, over-rigid in the cartilages and ligaments, which allow it motion by the ribs, very hardly yields to the now debilitated or more inert diaphragm, and other respirative muscles : hence the more laborous breathings and frequent asthma's of old people, joined with phlegmatic and catarrhus discharges from the lungs, and the whole via alimentalis, chiefly bred from the crudities or indigestions of the chyle, blood, and lymph, in the now weakened
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or inert vascular system, joined with an increased density or imperviousness of the cutaneous and renal emunctories; whereby the latter, losing their muscular power that conduces to empty the tubuli; become frequently charged with fabulous concretions or crystallizing granulations of salt and earth, which lay the basis of tormenting calculi, either in the kidneys, ureters, or bladder. The same rigid inertia of the solids may also ensue, so as to be retrievable, in younger persons, by medicine, from an excessive use of sea-salt, which draws out the jelly, both from the blood, lymph, and fibres, so as to render the former immotive, and the latter atrophic, or unfit for nutrition; and so do also spirituous liquors abused, but without leaving the solids, like the first, in any tolerable condition of recovering their due organic fabrication and vital motions, by a proper use of antiscorbutics. Hence the necessity of lessening the quantity, and of lightening the quality of the nourishments, taken by old people, who ought, if they are desirous or willing to keep health, to join them with daily walking and exercise, according to their ability: because an inertive or rigid debility in the chylificative organs, which are now loaded with unactive phlegm and mucus, instead of thin salival juices, and have a less quantity of a weaker bile, causes gross aliments (that require good teeth, at this time wisely rejected by nature, that they may be no invitement) to make a corrupt chyle in the first or alimentary passages, which cannot be corrected without light wines

wines and exercise, when they are once arrived within the sanguineous or second passages, now labouring with a proportionable debility. For in the aged, the actions of the heart, breathings, and pulse are smaller, slower, and weaker, as are all but the pituitary secretions. Their blood vessels, indeed, always appear remarkably full, from the increased density and spring of the capillary and muscular increasing over the contractile force of the trunks; by which, from slight exciting causes, the last often urge the blood, or its serous parts, very suddenly into the cellular or lymphatic fabric of the encephalon, spine, or nerves; whence sudden deaths, apoplexies, palsies, &c. hardly remediable: but as the blood and juices move slower in them, though with a greater compressure, they are less attenuated or digested, less able to afford repairing nourishment and nervous spirits; whence the coldness, feebleness, insensibility, and shrinking of old folks, with the whole train of chronical distempers, to prevent or retard which, daily exercise of body, which keeps the solids moveable, or from stiffening, and frictions of the skin, with plush or blanket, under the regimen before directed (§ 9.), will greatly conduce. See *Physiol.* §. 257. & seq.

§. 11. These states of the solids (§. 3, 4, and 8.) well considered, in conjunction with the climate, sex, occupation, and influences from the non-naturals, lay the only certain basis of a sound and rational practice; which, whoever neglects, builds on a vague fluxile foundation, that by deviating from the course
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of nature, will lead him into a field of unsound or conceited methods, whatever enthusiastical notions he may entertain of extraordinary assistances from God, by prayer. But if the fore-said physiological and pathological considerations be first duly weighed and understood (See remark at the end of Lect. VI. also §. 16, 23, 24, 136, to 139; 144, and 246, to 260.) they will afford a faithful guide, not only to know the constitutions or temperaments (§. 169.), by which people are inclined more to one kind of diseases than another; but likewise of that destroyed equilibrium or balance in the vascular system (§. 144.), which by errors in the non-naturals vitiates the motion, quantity, and quality of the blood itself, and its several secreted juices, which are often wrongly accused as prime causes in diseases. For the motion and quality of the fluids will be answerable to the proper conditions of the solids, by which they are formed; and the particular secretions and organical actions will be conformable to them both. Hence the quantity and quality of the fluids will be, as their motions; their motion will be as the quantity and quality, including the present state of the solids (§. 6, and 10.) conjunctly; and their vitiated texture or morbid qualities will be as the excess or defect in all the former together. Thus we have the first chain that holds the whole clue of distempers. A chain that admits of no motion or change in any one of its links, without proportionably shaking or altering the rest. See remark to the end of Lect. V.

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to which add, these causes variously excited, by other more remote or external and differently combined, lead us into the numerous kinds of fevers and inflammations, which, as they occupy above two thirds of the scale of all diseases, ought, by physicians more especially, to be well known and studied.

§. 12. From what has been said then, it appears, that the general affections of the blood, by which it may offend and produce diseases, are reducible; (1.) to *quantity*, redundant or deficient; (2.) to *motion*, excessive or defective; (3.) or to *consistence*, including its organical and albuminous *texture* and *coagulation* (§. 162, and page 144); also its febrile viscidness, either that commonly called a viscid, slow or cold *lentor*, from its causing slow, nervous, intermitting and hysterical fevers; (under which we include those which Dr. Hoffman and others call mesenterical) namely, such a cohesion of the serous and albuminous parts, in the least vessels, for want of a due nervous and arterial strength, as is similar to that in the whites of eggs, which by a moderate heat or concussion by a whisk, gain a watery fluidity: or else what is opposite to the former, a fizy phlogiston or *phlogistic tenacity*, i. e. inflammatory, from the former matter over condensed, by too great arterial pressure and motion, by which the serous and lymphatic globulus run together, into what is commonly called a buff or pleuretic crust, as soon as the blood is let out of a vein; as we observed more at large in Vol. I. p. 147. (4.) to *acrimony*; whether

whether chilly, as the alkaline, purulent, contagious, and gangrenous, or mixed with a corroding virulency, as the cancerous, venereal, arthritic and bilious, or those from a suppressed urine, or perspiration, &c. Only observe, that these affections of the blood and lymph, here proposed as the more general and nearer causes of many distempers, may be likewise introduced as effects consequent, from some other antecedent or particular diseases, excited by causes out of the present question; as the air, aliments, wounds, bruises, burns, &c.

§. 13. Let us now proceed to treat each of these morbid heads (§. 12.) with a laudable brevity. And first, too great a redundancy of good blood, oppressive to the arterial and nervous system, is called a *plethora*; which generally employs its force, so amply productive of diseases, sooner upon the encephalon or lungs, or the portal system of the hypocondriacal viscera, than upon other parts, as they make a less resistance in their vascular and cellular fabricature, to the impelled fluids. The frequency and fruitfulness of this morbid spring, in our indolent and voracious Britons and Hibernians, will excuse me for entering more minutely into its causes, signs, effects, and cure, than some other good professors have done before. (See remark to §. 14. *Physiol.* where (*ad vasa*) is by mistake transposed for (*ad vires*). Observe then, we are to consider an over fullness, either (1.) as it is (*ad vires*) oppressive to the powers of the heart and encephalon, by lying *dormant* in the less resisting cellular and capillary systems;

systems; or (2.) as it is (*ad vasa*) excited thence into the largest trunks and branches, which bearing a small ratio to the former, are thus easily over-strained or broken.

§. 14. A plethora, the signs of which include both the productive causes, and the consequent effects, varies according to its quantity or degree, its extent or seat, and the time it has continued. A chylous plethora soon breeds one that is sanguine, as that does one which is serous or lymphatic; and that by degrees unravels all orders of the web-like or cellular strata, surrounding the nerves and the least vessels, with the whole compages of the viscera. But the *generating and productive causes* are reducible to two heads; including (1) those which make more chyle and blood than are necessary for the sex, habit, or occupation: such are a strong stomach, bowels, and liver, joined with costiveness; foods and drinks highly nourishing, taken too copiously or too often in the day; an effeminacy in the habit, make, or proportions of the body in man; or those which are natural to a woman: to which add a sanguine temperament, and a short stature. (2.) Those which diminish the circular motion, triture, and expulsion of the blood and juices once formed: such as an effeminate weakness of the nervous, vascular, and cellular systems (§. 3.); a rigid or senile inertia (§. 10, ult.); a deficiency of nervous juices, either in quantity or quality; a recluse, unactive, or sedentary life, given much to reading or study; an adaphorous or careless disposition of mind, with

with too much indulgence of sleep ; or lastly, any accustomary discharges too suddenly stopp'd, diminished or neglected. These last may be subdivided into (1.) *natural* discharges ; from the hæmorrhoidal vessels, womb, intestines, kidneys, skin, spitting or coughing, &c. or (2.) *artificial* ; such as blood letting, cupping, setons, issues, purgatives, clysters, salivating, snuffing, chewing, or smoaking ; or lastly, (3.) such as are *accidental* ; viz. from wounds, hæmorrhages, ulcers, amputations, &c.

§. 15. The preceding causes may indeed accumulate too great a quantity of good juices in the cellular system and least vessels, so as to produce a suffocated or latent plethora, that may gradually vitiate the whole habit by a cachexia and cocochymia ; but if this dormant fullness be suddenly *excited*, or driven from the smaller vessels and stagnant cells into the larger trunks, which have a much less ratio of capacity than the capillaries, it will be then an excited plethora ; which may be suddenly fatal, by exerting its violence on some of the important viscera before mentioned (§. 13.), if not timely relieved by the lancet, with other evacuations and revulsions. Such a fulness, without artificial evacuations, can only be removed by exercise, gradually increased, with a subtraction from the diet, as those well know who deal in fine horses ; having learned by experience the fatal effects of removing them suddenly from long rest to violent or swift labour, which if not presently fatal, seldom goes over

without leaving staggers, bad wind, or a consumptive pining from injured bowels.

§. 16. These *exciting causes* (§. 15.) seem reducible to the following heads; which include all powers that suddenly augment the motion or quantity of the blood, from the cellular fabric and smaller vessels, into the larger trunks of the venal and arterial systems: such as (1.) a too sudden and intense heat or cold, weight, or levity of the incumbent atmosphere; (2.) all acrimonious or stimulating substances, which suddenly or powerfully excite the muscular constrictions of the heart and arteries; taken either as *aliments*, changeable in the first and second passages, into the albuminous juices of the body itself; or being in a small degree above those changing powers, and called *medicines*, excite salutary commotions, which throw them off with the containing humours, by the emunctories; or lastly, being disobedient by their quantity or quality, both to the said digestive, and to the excretive powers, remain within the habit, which they sooner or later destroy, under the denomination of *poisons*; the particular classes of all which may be taken in, either by the common alimentary ways, or absorbed through the skin, or lungs: (3.) sudden or unaccustomed excesses in venery, exercise of body, cares, or watchings, anger, joy, envy, &c. augmenting the nervous and muscular forces of the heart and arteries, to a febrile height, that soon vitiates the whole mass, so as to be not unrarely fatal. And here we may observe, that such nervous
fevers

fevers have different symptoms in the viscera, according to the nature of the passions they arise from. Those from excessive joy, kill often as suddenly as the plague, by over dilating all the external and internal pores, and a sudden dissipation of the finest nervous lymph that ought to supply the encephalon; as in the remarkable instance of the baronet's son, upon coming to his estate, mentioned by Dr. Nichols, in his late lecture de anima medica, p. 16. The like we remember, from a sudden or unexpected preferment, in a man of weak irritable nerves, to a stewardship, under the late prime minister Sir R. W. &c. Those from grief, convulsively affect the nervous and muscular fabric of the stomach, porta, and liver; whence anguish, with hiccups, and a fever that is complicated, or in part icteritious and colliquative; as was the fatal case of the late colonel Stewart, at the loss of a bribed or forstalled preferment, whom Dr. Shaw visited, &c. (4.) excess of spirituous and fermented liquors, especially such as are replete with a great quantity of incorporated air (§. 159.), which is often confined in bottles or close vessels, as in champaigne, new wines, ale, cyder, &c. but this by great heat of body and weather expands itself into an elastic state, not only in the stomach and first passes, but also in the blood itself, so as suddenly to affect the nervous system, and sometimes in a fatal manner, as in the late eminent Mr. Chelfelden. (5.) And lastly from pain or irritation of any kind acting on the encephalon, or

nerves, or heart, and arteries, from causes external or internal, in some one part, or throughout the whole habit, originally or by consent of parts (Physiol. §: 555.), &c.

§. 17. The morbid *effects* of a plethora, which has arrived to any considerable degree, in a state either dormant (§. 14.) or excited (§. 16.), are various and almost innumerable, according to the circumstances, (§. 14.), habit, complication, &c. Infomuch, that different lengths of this chain will lead us to its source, as a primitive internal cause, either principal or accessory, producing the majority of diseases, both acute and chronic. Let us then first endeavour to reckon up the effects of a *dormant* fulness, as near as we can, in the order they stand connected, or are productive of one another: such are, an impediment of the circulations, secretions, and excretions throughout the whole habit; too great a distension and unravelling of the cellular fabric, least vessels and nerves, wherever they are the most lax, and return the least action upon the fluids; thence a weakness in the contractile, automatic, spring or tone of the solids, and of their muscular, nervous force likewise. From thence the juices by degrees contract a cold, aguish or albuminous visciduity; the crassamentum is neither sufficiently dense or abundant, whence a chilly leucophlegmatic habit, and by degrees a cold scurvy, that may end in a fatal wasting, or a dropsy. From the said causes ensue a stupidity of the mental, and a laziness of all the bodily faculties, with a perpetual inclination to dozing and sleep.

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The skin appears pale or livid, and bloated or œdematus ; and half-moon-like distension of the veins and cellular fabric, appears under the eyes, with a pallid turgescence of the lips ; the pulse is full, weak, slow, soft, and easily fluctuating ; the urine, too much for the quantity of drink, and either clear (at times) like water, or else milky, with a white or reddish sediment, and a shining skin on the top ; the eyes swelled, watery, and red without heat, impatient of the least cold wind, especially upon first arising in a morning ; the blood too poor, loose, or serous, not half crassamentum, as it ought to be in quantity, and breaking with a pressure much below its healthy standard of cohesion * ; the serum too saline, brackish or scorbutic, and the blood either too pale, from an offending acidity, or of a violaceous and dark purple, from any putrid or alkaline cause. At length may follow cold or white swellings in the joints, and lymphatic glands, of the most stubborn or scrophular disposition ; with nervous atrophies, and slow fevers of all kinds, whether scorbutic, mesenterical, hysterical, leucophlegmatic, intermitting, nervous, &c. To which add many chronic affections, nervous wastings, dropsies, green-sickness fluor albus, diabetes, night-sweats, &c.

R E M A R K.

* Which should be about eight drams, to break an hemispherical base, or surface of the cruror $\frac{1}{3}$ d of an inch in diameter, after standing 12 hours in hot air, or 24 in cold ; whereas in fevers not colliquative, at or before the height it bears upwards, to 70 drachms ; as you may both usefully

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and conveniently experiment, by carrying in your pocket an ivory tube, of the said bore, 9 inches long, and holding a range of cylindrical dram-weights of lead; by which, having an outward scale, you may also measure the specific weight of the serum and urine, by suspending with a hair to keep it upright in the fluid.

§. 18. The preceding section has given us a view of the consequences, which ensuing from a dormant neglected plethora, may in time excite most chronical disorders, with many that are in part inflammatory, only inclining to the more slow or nervous kind. Let us now see the *effects* of an *excited*, febrile plethora (§. 144.), which from some stimulus of the nervous or arterious systems, soon urges the blood and finer juices from the cellular and capillary systems into the larger sanguineous trunks, through which they make a quicker transit to the heart, not only naturally, but more now, as the greater distension of the trunks compresses or shuts up the capillaries, which ought to retard the blood's regress to the heart, and differently in different organs, to form the various secretions in due quantity or quality (Phys. §. 174.); by which means mere fulness of good juices, kept for too long a time in too rapid a motion, will soon cause such a phlogistic lentor as lays the basis of all true fevers, plurifies, &c. as we described it in a remark to Physiol. §. 161. Hence a plethora, dormant or excited, sanguine or cacochemical, appears next to a vitiated state of the solids, from whence it chiefly

chiefly arises, to be plainly the most fruitful parent of all other diseases.

§. 19. The consequent *symptoms*, signs or effects of a dormant plethora, excited by any sudden commotion of the nervous or arterial systems; are (1.) speedy weariness, a short-breathing, and a sensible throbbing of the arteries throughout the body, even from slight exercises of body, passions of the minds, or other motive causes (§. 16.). (2.) A turgescency of the veins and skin, with flushings of the countenance. (3.) A pulse that is somewhat soft, but large or full, and very labouring. (4.) Erroneous strayings of the red or yellow parts of the blood, into the smaller white vessels and continuous ducts, which ought to resist and confine them within the sanguineous system. (5.) Anguish or oppression in the viscera that surround the heart; and periodical pains, chiefly about the head, back, sides, or joints, either rheumatic or hysterical. (6.) Morbid, colliquative, and weakening discharges, from slight spastic commotions of the mind, exercises of the body, or small excesses in the non-naturals; a weak, watry suffusion of the eyes, night-sweats, or a diabetes, which appear at times, form spastic commotions of the nervous system. (7.) If the strength and resistance of the cellular fabric and the pellucid vascular systems which attend it throughout the body, confine the excited plethora within the large sanguine arteries and veins; the exciting causes still continuing, will bring on acute continual fevers of all kinds; or if the causes urge more

upon any particular part, weaker than others, true inflammations ensue, either with or without a considerable fever. (8.) Or if the said cellular and pellucidly vascular fabrics yield too easily to the nervous and arterious powers, now urging the blood with too great impetus from the exciting causes (§. 16.) ; thence follow aneurismatic, or varicose tumors of the larger vessels, or œdematous swellings of the least pellucid ones and cellular fabric, more especially about the encephalon and nerves, under a senile rigidity of the solids, or cold viscosity of the fluids ; whence lethargic, apoplectic, paralytic, convulsive, and chronical, nervous disorders of various kinds.

§. 20. The treatment or cure of a plethora ought to vary according as the general or particular causes (§. 5, 14, and 16.) and their effects (§. 19.), joined with the circumstances of the patient, and the time, extent or degree of the disease itself, may point out to the prudent and slow formed judgment of the physician, who is consulted. The generating causes (§. 5, and 14.), call for correction by their contraries gradually introduced (§. 6.), and as gradually abated, after the cure is confirmed ; in which lies one of the most important branches of skill in the art of healing : but the exciting causes (§. 16.), to prevent sudden and fatal effects, require to be quelled immediately, by blood-letting, cupping, lenient-purgings ; and revulsions from the important parts more immediately affected, by blisters, issues, clysters, &c. Let the sleep and diet be gradually lessened, espe-

especially in summer, and the exercises of body proportionably increased (§. 6.); only observe here, that such as cannot confine their appetite to a small quantity, should at least abate in the quality, i. e. to use aliments less nourishing, as are all those preserved by salt, vinegar, spices, &c. the wines dry, Florence, old-hoc or rhenish, reduced by degrees to a moderate quantity, and qualified with water, either drank separately or in commixture.

§. 21. Here it may not be improper to speak a word of phlebotomy, which being itself an instantenous and temporary cure for every sanguine or excited plethora; and a necessary means to palliate the numerous symptoms (§. 19.) that ensue from it, may be justly esteemed one of the most extensive and potent reins with which physic is provided for the prevention, government, and cure of those acute, febrile diseases, which are not only the most head-strong and fatal to mankind, but also double the number of the rest upon the whole list; and from whence most of the others, which kill more slowly, or in cold blood, also derive the origin. Observe then, that as the lancet is generally productive of the most immediate and powerful relief in urgent cases that lie under the direction of a prudent physician; on the contrary, a repeated use of it, without occasion, either as a preventative remedy, or in cases seemingly urgent, where yet it is improper, we daily observe to be productive of the greatest mischiefs; although sometimes these last are both necessary and unavoidable evils, to prevent

prevent others that are yet greater; as e. g. when a febrile lentor has settled on the lungs, and to avoid certain death by the head-strong and peripneumonic fever, many of the small vessels contract and close up in the lungs by numerous bleedings, and leave afterwards an habitual asthma from callosity; or when foolishness follows after a fever, or a phrenzy from the same causes, in the encephalon; or a returning paroxysmatical jaundice and dropfy from the like in the liver.

§. 22. The only rule then to be relied on, for directing this discharge to be repeated with salutary effects in all doubtful cases, is, the standard of the blood's cohesion; to be known by experimenting in the manner we before mentioned, after §. 17: for whenever it is buff, or refuses to break by the pressure of 8, 10, or 12 drachms or degrees, you may be sure phlebotomy, in moderate quantities, is proportionably a laudable remedy.

2. Though there are some cases where the colliquative power of matter, returned from a vomica of the lungs, or other viscus, will overballance the coagulating force of the hectic, so as to afford a lax and florid blood, when still a repeated use of the lancet is necessary to reduce the vital forces of the heart and arterial system (by which matter is formed) to so low an ebb, as may allow the broken or ulcerated vascules to close up, and harden through want of influent juices, in the same manner as a profuse hæmorrhage may save a person fatally wounded, by inducing a weakness of the heart and arteries,

ries, which excited, would soon be destructive. Hence the use of blood-letting in small quantities, and at proper intervals, for the cure of pulmonary consumptions, to prevent miscarriages, to palliate cancerous swellings, &c. which the vulgar too often condemn as bad practice.

3. On the other hand, in any cachectical or cacochymical plethora, which being long neglected, has induced a cold albuminous lentor, and a watery, acrid, or dissolved state of the blood, unable to support the pressure of 8 drams or degrees; blood-letting will have no good tendency, even though local pains from the said lentor, or œdematous inflammations of the eyes and other parts, from an erroneous straying of the red cruor, or yellow serum of the blood, may seem to some to be indications for it. But serous depletions, with blisters and scarifications into the cellular substance of the arms and legs, in people not old; with the other alterants and corroborants before directed (§. 6.), alkalies, bitters, and aromatics, gradually introduced, will operate a lasting cure.

4. Hence, when the menstrual passages have remained blocked up many months, whether by a rigescence, lentor, or an organical spasm, the taking cold, or a paralytic laxity of the organs; every bleeding will increase the caco-chymical plethora and its consequences, although it seems to give a present relief: for to bring the uterine discharges in such a case to be regular in quantity and consistence, requires first an improvement of the blood itself, by the course of §. 6. afterwards an excitement of the plethora, now sanguine by medicines, properly

deobstruent and uterine, [Ext. Helleb. | Flor. mart. | Cinnab. Ant. | Pil. Gum. | Tinct. valer. &c.] with such as are in this case derivative of a greater flow into the lower system of vessels (vol. I. p. 133, ult). viz. warm bathing of the feet, and applications of warm, cephalic plasters, hysseric clysters, and exercise of body, carried up to an incipient sweat, at the time when they are most likely to break forth, &c.

§. 23. As phlebotomy always increases the circulation through the parts which are nearest the vein opened, for some considerable time after the operation; therefore bleeding in or near the parts affected, is always derivative of a greater flux to them; as on the contrary, it is always refulsive when performed in parts that are the most remote: consequently, to abate an excited universal plethora, it is indifferent in which part, whether arm or leg, the vein be opened; but for the removal of obstructions or cloggings of the vessels, by any cold viscid lentor, settling on some organicle part, [as in a periodic cephalalgia from that cause, often called an ague in the head,] bleeding in the jugular will there conduce to remove the load, by more increasing for a time the strength and action of the vascular system, and so will bleeding in the foot with respect to obstructions of the menses.

2. But since bleeding in the arm or neck requires the use of a ligature, from thence the blood-vessels of the parts intercepted are more entirely emptied, by the sudden filling of which, upon taking off the ligature, a revul-
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sion is instantly made thither from the vital organs; whence those who are weak, faint, upon untying the ligature, so soon as the loss of spring or arterial tension reaches the heart and encephalon: but as bleeding in the foot requires no ligature, only the use of warm water; therefore in all inflammatory cases of the head, breast, or abdomen, it makes the best revulsion both of fullness and phlogistic tenacity; as it at the same time makes a strong derivation to the uterine or hæmorrhoidal vessels; and all this without subjecting the patient to faint, unless the quantity be excessive, because the depletion is every moment transferred equally throughout the whole, without falling at once suddenly on the heart or encephalon, as it does by the use of a ligature. (See the remark to §. 142. vol. I.).

3. But the case is otherwise in cupping with scarification, which evacuating more of the febrile lentor, without weakening the arterial or nervous systems, always makes a revulsion from the internal parts, or a derivation to the skin outwards; and is therefore the most useful when nearest to the vessels communicating with the parts affected. What we have here said of revulsion and derivation, may be also applied to blisters, pains, or any local stimulus; and in some measure to purging, vomiting, or sweating, by external heat. But for inflammatory and plethoric affections of the kidneys, bladder, and genital parts, bleeding from the arm will undoubtedly have a better effect; as also in some cases not inflammatory, where the tone
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of those vascular parts is to be recovered in a diabetes, whites, feminal gleetings, &c.

§. 24. The other vice of quantity in the blood and juices, productive of diseases, is that of deficiency or *inanition* (§. 12.), which indeed may be often itself a distant consequence of a dormant fullness, too long neglected, as we before observed (§. 17. ult). This spring of diseases, being most commonly known by the name of a *nervous atrophy*, imports a mere collapſion of the cellular, vascular, and muscular systems, with universal weakness, from too great wastings, or too small recruits, of chyle, fat, blood, lymph, and albuminous nourishment throughout the whole habit, without any ulceration or organical destruction of the solid vessels and viscera. This, like a plethora, varies according to the time of its duration, and extent within the habit, by passing from one organical system to the other; because a great deficiency of the chyle will cause one of the blood; this, one of the fat, lymph, albuminous nourishment, and nervous spirits: so that though the last link of this chain, over worn, or wasted by irritation, either upon the nervous or arterial system, seems by way of eminence, to have given title to this disease, or rather complication of distempers; yet we see it is as often produced by defects in some of the antecedent links, which necessarily sustain the latter.

§. 25. The *causes* therefore of inanition and atrophy, seem reducible to the following heads: (1.) an over weakness or indigestion of the chylicative organs, both in the tone of their elasticity,

elasticity, and their muscular forces (§. 3.), whether habitual, from the age, sex, or birth; or acquired by excesses in eating or drinking; violent purges, vomits, or clysters too long used, &c. whence a cocochylia, either oily-rancid, sour, putrid, or viscid, according to the corruptive nature or inclination of what is taken into the stomach, upon which it makes too long a stay. (2.) Aliments in themselves too oily, heavy, poor, acrid, or tough and viscid, for the age and exercise; overcharged with salt or vinegar, which destroy their gelatinous or nutritious parts; or else which is rarely the case in England, by starving the meals, taking them in too small a quantity, or at too long intervals. (3.) An over tenderness and irritability of the nervous system, too easily disposing to cramps and wastings, or profluvia of the emunctories, hysterical hectic, &c. (4.) The heart and arteries too much irritated, either from a want or an excoriation of their defending mucus; or from their nervous and muscular forces, excited by passions, pains, &c. or by a scorbutic acrimony of the influent blood. (5.) A weakness of the arterial and nervous powers by immoderate venery, drinking, watching, labour, grief, desire, or love, &c. (6.) Excessive hæmorrhages, or other discharges, whether natural, artificial, or accidental (§. 14. ult.). Lastly, (7.) from a dormant fulness, inducing by time and neglect all the consequences before mentioned (§. 17.).

§. 26. The cure or treatment of a nervous wasting may in a great measure be derived from

§. 6, having at the same time a regard to such of the productive causes (§. 25.), as are more directly concerned in the case consulted. The atrophy that is chylous, from indigestion and a viscid obstruction of the *mesentery*, which as Dr. Radcliff judiciously observed (V. Cowp. in Tab. 34. dict. Bidlowi anat.) kills a great many of our infants and elderly people; is best attacked with small boles, ex Rhab. & Calam. at proper intervals, followed with Tinct. Guaiac, vol. and the nervous deobstruents (§. 22. ult.), with much riding in a rough-hac upon the stones, &c. Observe to correct the cacochyliæ, if oily or putrid, by small doses of the cort joined with mineral acids; or if the first passages be sour or mucous, give the same with sal. diuret. or give the Tinct. cort. P. vol. | T. guaic. vol. & valer. vol. entering on them, and leaving them off (paulatim.) by doses gradually increased and diminished. That wasting which comes from irritating causes (§. 25. n^o 3. to 6.) must be relieved by abstracting the stimulus, and appeasing the irritation by nervous, papaverine, nitrous, and mucilaginous medicines, in bol. & haust. | flor. mart. | troch. è. succin. & è nitro. | pulv. è. trag. | pil. è. styr. | pulv. e. bol. c. cum op. | haust. salin. cum sperm. cet. | syr. mecon. asses milk, &c. That from excessive discharges (§. 14 ult.) must be restrained by the same, and by §. 6. For scorbutic, hectic atrophies, in sea-faring gentlemen, golden-pippins and nonparels, scooped in good plenty, are highly useful, and Tinct. cort. cum elix. vit. d. but avoid milk with them, or even whey, if it
sours

fours upon the stomach ; for then brod. viperar. cum pullo will be preferable.

.2. Those scrophulous and cancerous erosions of the womb, bladder, mesentery, pancreas, liver, stomach, fauces, mouth, &c. that often follow from, or are joined with a cacochymical neglected fulness, in women past child-bearing, or from excesses in cachectical men, &c. are seldom more than to be palliated as above, by keeping the circulation as low as possible, and using a very light or thin diet. When the nutritious powers are reduced to their lowest ebb, the white of a fresh egg, mixed with a gill of sweet whey, when asses milk cannot be had, with or without sweetening cum syr. de mecon. may be given to advantage every three or four hours ; to which add, for change, the jellies of fruits, hart's-horn, new creams diluted with tea, almost cold, broths of lobsters, or rather cray-fish, boiled with rice, or with crust of bread that has been well baked, &c. joined with the exercise of carriage to a proper distance, first in an hand-chair, then in an horse-chair and coach, &c. and ascending to a stronger diet and exercise by degrees, (§. 6. per tot.).

3. In some sour stomachs, the acid incentive so penetrates into the membranes and viscera, (as we see the bile penetrates the coats of the gall-bladder and colon) that by operating immediately on the vegetable or acescent part of the aliment, the whole even though it may be in a great measure animal substance, soon becomes a corroding-acid, or indigestible mass: for 'tis, by this incentive acescent power, a little scrap of the

dried stomach of a calf, macerated in water, makes rennet, for curdling milk, &c. For such stomachs, therefore, mere broths of cray-fish, vipers, chicklings, jellies, custards, &c. will be preferable, without any acefcient substance.

§. 27. We have now seen, that the fluids, offending by excess or defect in quantity (§. 12.), will always either abate or increase their motion above the healthy standard, that is or ought to be constitutional; whence a vitiated quality or texture may, by degrees, soon spread itself throughout the whole habit, in all the numberless disorders, imputable either to a plethora (§. 13.), or a wasting of the fluids (§. 24.), or else to their motion, consistence, or a morbid acrimony; which two last always offend, in proportion to the excess or defect, and duration of the former. The healthy motion then of the fluids, which alone keeps them from running into the cohesions of a solid (Physiol. §. 1. and remark to §. 161.), may, like their quantity, offend by excess or defect; and that, either universally, throughout the whole habit, or locally, in some particular organ or viscus, to be understood in a proper latitude (§. 2.). But as this equable and healthy motion of the fluids is relative to the age, sex, climate, season, &c. (§. 137 and 138, Physiol.), so their morbid excess or defect, as to the said motion, may be judged of, under these circumstances, either by respiration or the pulse; the former of which, with Hippocrates, we esteem a more certain and instructive sign in acute diseases, than even the pulse;

only it requires more attention, and a longer course of observation, to bring it to the same uses in practice. (1.) A deficiency of motion in the fluids, being generally introduced with all its chronicle effects, in a manner insensibly from a dormant or neglected plethora, joined either with an effeminate relaxation or a senile rigidity, it may be known and treated, from what we have before advanced under those general sources (§.1 to 27.).

Of Fevers.

§. 28. But (2.) a too quick motion of the humours thro' the arterial and nervous systems while the body is unexercised, causing an uneasiness, with an over increase of the heat and actions of the organs, throughout the habit, is called a *fever*; but when it is sensibly extended no farther than a certain part of the body, it is called an *inflammation*. Every fever then is the effect of some stimulating cause, operating on the arterial and nervous systems, and thereby urging the heart to larger or more frequent contractions; as every inflammation is the consequence of like causes, locally confined, and irritating the muscular systaltic contractions of a particular artery and its branches; which is again more intence, as the tonical or elastic force of the said artery is raised to a greater height, by a fuller distention of it with juices. (Vide Phys. §. 44. remark). Hence the reason why a stymulus will put a nervous or plethoric person into a fever; that in others, of a low, sluggish or poor habit, will only add strength, or even cure a chronical distemper. And, therefore, the

causes, which create a plethora, and more especially those which excite it (§. 6.), are particularly productive of fevers and inflammations, which being always, more or less, joined one with another, and making the most common, either causes productive or symptomatic attendants of other diseases; in a due knowledge and treatment whereof, our medical skill is capitally employed: we shall, therefore, for our own satisfaction, as well as that of our younger brethren of the faculty, attempt to delineate a concise, but just and plain pyretologia, conformable to the best physiological and practical lights we now have.

§. 29. The most useful and primary distinction of fevers seems to us, therefore, deductory, (I.) from the seats of residence of their principal or stimulating causes that too much increase the heat and motion of the blood, or induce most of their inflammotary and discriminative symptoms; or, (II.) from the nature and operations of the said material causes, to be subdued or removed by art and nature, seperately or conjunctly employed. By the first, we divide fevers into (1) such as are contagious or cuticular, in which the febrile cause enters through, or acts principally in the fabric of *the outer or inner skin*, with which the air and aliments, with all they contain, have a free communication or contact; for, in these, an epidemical or contagious matter, of various kind and origin, takes up its residence in the mucous, sebaceous, and serous pores, follicles, and cryptæ, not only outwardly, but more eminently in the airy and alimentary passages, where they slowly spread and corrupt

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the juices, with the villous epithelium and adjacent cellular fabric, much after the manner of a venereal gonorrhea; whence ophthalmias, coryzas, coughs, peripneumony internal; fore-throats, œdematous, gangrenous or convulsive, or both gangrenous and convulsive*; inflammations of the stomach, incessant vomiting of its contents and diarrhœas, bilious, serous, sanguine, &c. But if the said matter be disposed to go further than the alimentary mucus, with the chyle, blood, and lymph, it commonly excites a fever malignant, of a particular kind, by attacking the encephalon, or eruptive, in the external skin. The cure in such cases, is by an evacuation of the offending matter from the parts principally injured by masticatory, vomit, purgative, clyster, warm bathing, &c. and a moderate elevation of the vital powers, by acescent drinks, with nervous diaphoretics, blisters, &c. observing to keep up the sound texture of the solids and fluids against the colliquative force, by a due use of min. acid. in tinct. with bark, camph. nit. sal. armon. &c. See physiol. remark to §. 164. In the first stage of these fevers, often a moderate blood-letting, in those who are plethoric, will so relieve the oppressed heart and encephalon, as to produce, like a cordial, a more easy and happy issue or expulsion of the offending matter towards the skin; provided the blood's cohesion be above the healthy standard (§. 17.)

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* When the infectious saliva of a mad animal has multiplied and nestled to a certain quantity,

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within the villous covering of the phauces, gula, and stomach, either by passing thither immediately, by kissing and flaving with a mad cat, dog, horse, &c. or more remotely and slowly, by passing thither through the blood, infected by a wound or bite. It being the nature of this rabious poison not to operate mortally, by a dread of water, until it has excited a gangrenous inflammation in the said villous lining (somewhat similar to the action of variolous infection, that exerts its force on the true skin) whence, by a nervous consent, it also, for the most part, causes a fever, delirium, and convulsions, which are not so soon fatal, as those from a gouty or strong pestilent matter, acting on the same parts.

§. 30. The *second* class of fevers (§. 29, I.) arise from a stimulating cause, or febrile matter seated *in the blood* and lymph, with a tendency to dissolution or digestion by the fever itself, aided with antipyretic medicines, so as to pass off, either insensibly or apparently, by the skin or kidneys, which are the natural emunctories to the sanguineous system, and vicareously substitutive one for the other; or else less naturally by a diarrhœa, either critically or artificially excited. To this head we refer all slow, anomalous, and seemingly nervous fevers, arising from a cold, indigested, albuminous viscosity, extended through the chylificative and sanguificative systems, (from the causes of §. 4 and 5.) and often extending even into the encephalon and nervous system, when it excites fevers, either truly spastic and nervous, or else those which we call local and irregular intermittents with such as Dr. Hoffman and his prede-

predecessors have properly called mesenterical*. Add to these, such as we term remittents and intermittents, and which after a small continuance of the fever, and a bole or two ex rhab. and cal. always yield to the bark, with or without an emetic and nervines.—But besides this more weakly-stimulating, albuminous, or intermitting viscosity abovesaid, which, by often settling in the abdominal viscera, lungs, or encephalon, causes a variety of hippish, hysterical, nervous and polymorphous fevers, there is a stubborn phlogistic or inflammatory matter arising from opposite causes (§. 8 and 16, and *Physiol.* p. 147.), by which the blood tends to too tough or coriaceous a consistence, joined with pains, either in the side, limbs, or other parts; as we know by that appearance of the blood, from whence we call it buff or pleuritic. And this, with an hard pulse and a clear urine, we esteem the characteristic of an inflammatory fever. But observe, this lentor, by a continuance of the fever beyond its height, with blisters, diluents, attenuants, saponaceous dissolvents, &c. will not only melt and run off in a thick matter critically by sweating, purging, or urine, but sometimes the healthy glutinous cohesion, of the red and other parts of the blood will, by a continuance or increase of the same causes, acquire a putrid or gangrenous thinness; whence a new fever, of a different kind and treatment, will arise, commonly called colliquative; because here the permanent texture, connexion, or glue of the red and yellow globules of the blood being dissolved, as

when you mix it with an alcaly, it runs to waste through the skin, kidneys, or intestines, &c. (V. Physiol. vol. I. p. 153, & seq.) In which cases, mineral acids, with the bark, make a divine remedy, that would do great mischief, before the digestion and height of the said inflammatory fevers have dissolved the lentor.

R E M A R K.

* (Therap. de morbis dignoscendis, c. 3. §. 6.), which I have sometimes known, as a local remittent in the mesentery, productive of a slow irregular fever, with a wasting serous diarrhœa, that has exhausted the patient, in six or eight weeks, to the lowest degree of an atrophic, with an exfoliation or renewal of the whole internal villous epithelium from the alimentary tube, and even bladder, in an ingenious apothecary, whose tedious cure passed from me to that of Sir Ed. Hulse; for when the whole mesenterical colluvies had ran off, almost at the expence of the last drops of nature's forces, that gentleman's recovery was no less sudden than surprizing to every body. Here the fever is irregularly remitting, very little inflammatory, and the blood in good condition; the pulse and breathing in no wise intimidating; the urine sometimes crude, pale or nervous, and, at times, depositing a sediment, with a good deal of ropy viscid matter and surfuracious or cuticular exfoliations from the villous lining of the bladder; the tongue sometimes furred white, or but little inclined to yellow; the eyes, as in an œdematous ophthalmia, from weakness; the sleep short, and often interrupted, with a load or oppression in the lower-belly, although you have a purging, &c.

§. 31. The *third* and last class of fevers, necessarily distinguishable by the seat of their cause
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(§. 29, I.), includes those that arise from some inward stimulus on the encephalon, or any nervous part thence proceeding; and this either alone or conjoined with some other primary or considerable vice febrific, either in the first passages, that convey the chyle (§. 29.), or the second, that convey the blood and its serous juices (§. 30.). And these are the fevers, which, in the strictest sense, merit the title of *nervous*, or low; because of the low spiritedness, sighing, soft and weak pulse, inconsiderable heat, and propensity either to a copious watry urine, (not improperly called nervous or hysterical) or sweats of the same kind, which surprisingly exhaust and debilitate the patient, with respect to his whole nervous system; because the finest gelatinous lymph, that should afford immediate supplies to the encephalon and nerves, is exhausted by those drains, or thrown out from the blood; in which we are confirmed, by the unacid or sweet, and clammy nature of both those discharges; or it may be by insensible exhalation, excessive in too warm a climate. Here then the immediate cause appears to be a too defective or imperfect repletion of the encephalon and its produced nerves, with that fine, organic, or globular lymph, which, from the quickness of its operation, betwixt the active soul and body, rather than from any similitude of substance, we call animal or nervous spirits. This deficiency may arise from all the causes (§. 25.) that exhaust them too fast, or else make them too slowly (§. ib.); particularly a weakness, both tonical and muscular (§ 3.), through-

throughout the arterious system, and relaxations (§. 4.) of the cellular webs, that are not only interposed throughout the organism of the encephalon, but also betwixt every single tube and fasciculus that compose the nerves, which, thus wanting a due lateral resistance, too easily are over-distended by urgent passions of the mind, &c. In some weak studious men and women, a sudden abatement of the air's pressure on the body, upon an empty stomach, when the weather is hot and moist, will so far weaken the arterial spring on the encephalon, as to have the effects of a profuse bleeding, and excite a proportionable degree of this fever, which soon yields to a little fresh air in a coach, orange juice, and rhenish or other light wines, with or without the cortex and nervous medicines; premising, before the last, a little bole expulv. rhab. or an ounce of the infus. sen. &c. to wipe off the redundant pituita, that commonly overcharges the first passages in such habits. To this head belongs the febricula, of which Sir Richard Manningham has given a whole treatise; but such as considers it, I think, as a part of hysterical disorders, more than any original or primitive fever. 'Tis true, that an inflammatory or pleuritic lentor of the blood and lymph may, in the advance of adiapneustic, catarrhal, and other fevers settle in the encephalon, and so intercept its secretion to the nerves, as to excite many of the symptoms proper to nervous fevers; but then the stupor and contrariety of connected causes (§. 8.) will plainly enough point out, to the judicious, the wide difference there

there is, both in the nature and treatment of those malignant, from the present nervous fevers; in which last all evacuations, heaters, and sudorific medicines are highly injurious, except blisters, that are of common benefit to both, although in a different way.

§. 32. As the most common material cause of these nervous fevers, is a cold albuminous viscosity of the lymphatic juices, affecting the cellular and nervous systems, like as the crude viscosity in the sanguineous system (§. 30.), is the common cause of intermittents and remittents; therefore many of the bitter, foetid, moderately aromatic, and nervous medicines, are equally salutiferous in both: only the admirable cortex you must never use here, any more than in the former, until the pale nervous urine begins to form a lateritious separation or hypostasis. For unless the febrile matter of these, as well as of many intermittents, be first returned from the serous, cellular, and nervous, into the sanguineous system, to which last the force of the cortex is principally confined, it will exclude or bind up the matter within its weak bounds, so as to confirm or increase the distemper; whereas after the said matter has been somewhat attenuated, [by blisters, haust. salin. julap. camph. tinct. valer. vol. &c.] it will return into the blood, after a few paroxysms or emetics have shook the habit, and may then be happily and insensibly exhaled by the cortex; which, for want of this precaution, often fails of its admirable effects in nervine fevers, by locking up the course betwixt the serous and sanguineous

sanguineous systems, much as it often proves a useless load or clog to the first or chyliiferous passages leading to the blood, when filled with viscidities; until you have removed the last by a bole ex rhab. cum calam. or an emetic with haust. salin. camph. &c. Let, then, the lancet, with strong purgatives and sudorifics, be cautiously avoided in nervous fevers; but make free with blisters, vin. ipec. julap. cam. tinct. valer. vol. castor. &c. with plenty of sack or white wine whey. If the bed cannot be avoided, let the covering be as slight as possible, the air cool or temperate, the visitors few or none, the curtains and furniture violet, and a light barely glimmering or perceptible, the head cool and raised, the chamber often sprinkled with an equal mixture of good French vinegar and rose water, or a napkin dipped therein, and hung on the back of a chair near the bed-side; or if some passions or disturbances of mind still continues to intercept a recruit of spirits, by refreshing sleep, soft chromatic music, whose rithmus does not exceed or move faster than a healthy respiration, viz. about 20 or 30 changes in a minute, play'd piano from organ, harp, violin, &c. in an adjacent room, so as to be just audible by the patient, will often lead him into an agreeable slumber to good purpose. If the fever holds long, or is partly mesenterical, with an heaviness about the abdomen, 'tis of a grosser matter, that calls for lenient cathartics ex rhab. tinct. sen. &c. or if you find it comes to remit or intermit, it readily yields to the cortex, as above.

§. 33. The next useful distinction of fevers, inductory to a sound practice (§. 29.), we shall make from the particular nature, tendency, and operation of the material or febrific cause (§. 29, n.^o 11.), variously affecting the blood, spirits, and secretions, with the cutaneous and chyliferous, sanguineous, serous, cellular, and nervous systems, either in whole or in part, seperately or conjunctly, or by differing in degree or duration; whereby fevers are termed, either simple, symptomatic, eruptive; continual, remitting, intermitting, or complicated; inflammatory, by inspissation of the blood, lymph, and nervous spirits; or malignant, from a virulent or gangrenous colliquation of the nutritious albumen or glue, and of the organical or globular fabric, necessary in all those fluids to maintain life, nourishment, and animal sense or motion.

2. For when the elasticity and rotundity of parts in the said fluids, which keep open and pervious the least anastomosing vessels and nerves, is dissolved, the dead spring of the least arterial and vascular system, which they sustained, falls too much upon that of the trunks, and both over-resist the heart, as well as the motive or muscular powers from the encephalon to the arterial coats. Whence Dr. Hales has judiciously observed, that, in a dead animal, so thin a fluid as water, would not pass, by the same force through the capillaries, that were, in life, pervaded by so gross a fluid, as blood; which, by the rotundity of its parts, is fluxile to powers, that cannot move its cohesion to
itself

itself and to the vessels, when that fabric is dissolved, as it may in the manner we have observed, Vol. I. p. 152, remark to §. 164.

3. Now, in all the more simple or original fevers, which almost constantly begin with some degree of chilliness, followed with an ardency and painful uneasiness, there is besides other exciting or accessory causes, a certain febrile matter, either (1.) aguish or albuminous; or (2.) inflammatory; that is often called, pleuritic and rheumatic; or (3.) gangrenous; often eruptive, epidemical, or contagious, as we observed, Vol. I. p. 148, & seq. This matter requires to be digested by the fever itself, skillfully conducted or regulated through its several stages, that it may be afterwards critically expelled, by the powers of the arterial and nervous system, through some one of the emunctories, by which nature usually throws off all offensive matters; viz. through the skin, kidneys, or intestines, or more rarely by an hæmorrhage or a spitting. To stifle, then, or to suppress the fever, as may be, and too often is done, by excessive and numberless bleedings, acids, bark, incrassating, nitrous, purgative, &c. medicines, is not a curing, but only a postponing of the fever for a short time, or else converting of it into an incorrigible or chronical distemper, in some of the viscera; whence a patient is often soon after swept away, by a second and more violent attack from the first multiplied cause, or dwindles by some incurable, nervous, dropfical, or consumptive disorder; all which might have been prevented
by

by a prudent physician, who knows how to lead nature by the hand, in a pace that is neither destructively creeping, nor violent enough to run her out of breath. A patient and careful expectation, with due attention to nature, and the use of but few medicines, made the ancients superlative in the knowledge and treatment of these fevers; however, the advantages we have over them in practise, by an acquaintance with the bark, volatile alcalies and blisters, would nearly be equivalent to their superiority in point of observation, if those capitals were but more discriminately used, conformable to the individual kind, seat, and tendency of the febrile matter, with the stage of the fever, and circumstances of the patient.

§. 34. The general *cure* of fevers will then consist (1.) in an early cleansing of the first passages, by an emetic, lenitives, and clysters; (2.) in a repeated use of the lancet or cupping, as the increasing fever shall appear more inflammatory, or be joined with a greater degree of an excited plethora (§. 18.), in a stronger or denser habit of body (§. 8.), or threaten parts more eminently dangerous; as the brain, lungs, stomach, and bowels, &c. in all which, let the siziness or phlogiston of the blood be your principal director (as at §. 18.); lastly (3.) in keeping the febrile lentor within the high road of the circulation, that it may be digested by the fever itself, with proper attenuants.

2. This last intention (n^o 3.), after blister or lancet, is procured by vin. ipec. shocking the whole habit, and particularly the abdominal viscera;
in

in which, if the febrile matter settles, the blood turns from a phlogistic to a gangrenous or colliquative state by retaining the bile within the habit; whence arise a new class of fevers called bilious, that require a peculiar treatment, and diluent liquors, with nitre, sal. arm. camph. vegetable acids, blisters, honeys, testacea, &c. only be careful to give no emetic, when there is an inflammation begun on the diaphragm, stomach, or guts.

3. When the fever has thus tolerably advanced, we must watch the nature and tendency of the matter, whether it be inclined to pass off by the skin in eruptions, sweats, or insensible vapours; and accordingly promote it by mild diluents, papaverines, and gentle diaphoretics: or if it tends to the kidneys, by the same diluents, with emollient clysters, haust. salin. cum sperm. cet. sal. diuret. pulv. è chel. vel bez. confec. card. &c. or if it comes to a flux or purging, either promote it with small boles ex rhab. & cal. or only moderate it by papaverines, pulv. è bol. vin. ipec. julap. è camph. cum cret. &c. or if it tends to a spitting, give lac. ammon. cum flor. benz. & mel. elat. vel haust. ex ol. amig. vel. nuc. jugland. camph. sapon. amigd. vel sp. C. C. redact. & syr. mecon. &c. only see that the discharges you thus promote be not symptomatical, or exterminative of the salutary juices from the increase of the fever; but critical, i. e. from the abatement of it, and exterminative of the febrile matter; otherwise the former are to be restrained immediately by the lancet, with mineral

neral acids, nitre, papaverines, clysters, and refrigerants. For these symptomatical diarrhœas, whether naturally or artificially excited, often exhaust the thinner juices in so great a degree, that, upon bleeding, instead of finding half serum, the blood is often, above five parts in six, a solid mass; whence it soon blocks up the encephalon or lungs, and causes delirium or peripneumony, which, if not removeable by strong blisters to the soles of the feet, with acet. camph. and plenty of tartar whey, with clysters of the same internally, is soon fatal.

§. 35. The *billiary fevers*, well known, in hot countries, by the name of yellow, and sometimes not unfrequent among ourselves in warm and moist seasons, have, for their first origin, the same phlogistic matter (Vol. I. p. 147, and seq.) with pleuritic, rheumatic, and other inflammatory ones; which is not only bred faster, but more easily roused, by an excited plethora (§. 16.), in warm countries, where the continual heats, keeping the cutaneous capillaries always in action, prevent it from settling on that emunctory, and commonly excite nature to attempt its exclusion by the alimentary tube, towards which it has a natural tendency. But if now the matter, too crude or unprepared, is that way resisted, it soon settles on the liver and spleen, whose action it at first increases, by a slight inflammation; which soon after augments, so as to intercept the biliary secretion, and causes a return, of at least the major part of that strongly dissolving saponaceous fluid from the liver, by the branches of the cava,

into the whole habit, and that often in a more putrescent or exalted state, than is natural to the bilious juice, in a time of health.

2. Here then we have a fever, that justly claims the title of malignant, no less from the seat of its material cause, lying out of the high road of the circulation in those important viscera; to which proper medicines will hardly penetrate, than from the colliquative destruction the bile itself makes in the organical texture of the blood, lymph, and nervous juices. This fever is more violent, and apt to invade newcomers from our northern climates to the west-indies; because with us the natural emunctory, for viscid and peccant juices, which incline to fevers, is to run off by the intestinal tube, but, upon coming there, nature is, in a manner obliged to change her emunctories, and carry off gross viscidities by the skin, which, at home, she commonly threw off by the more lax, moist, and open pores of the villous alimentary lining; in which change, if she does not happily succeed, the consequence is a collection of the febrile lentor in the portal system, where, being roused by an excited plethora, an air uncommonly hot and moist, or an obstructed perspiration, it excites an original raging fever, that begins, with a chill, soon followed with a burning, with great oppression about the stomach, and a vomiting that appears generally bilious, but often black or bloody: at the same time too the head, neck, and back feel violent beating pains, as well from the strained blood-vessels here not being able to dilate the bony fa-

bric that confines them, as from the nervous consent the head has with the stomach and duodenum, at this time more or less inflamed, and oppressed with an offensive or corrupt humour. Here you have, even on the first day, or in a few hours, a rough, dark, dry tongue, with insatiable thirst, and often a delirium attending; and by the fourth day, the patient is either dispatched, or upon recovery.

§. 36. As this fever is commonly, at first, in part inflammatory, as well as colliquative, if we are called in time on the first day, blood may be let once or twice, according as its consistence and the patient's strength shall direct. Then give pulv. ipec. ʒβ in tinct. rhei vino℥ zij. to clear the way upwards and downwards. Next dilute plentifully with ascendent liquors, barley, or oat-gruel, with sp. vitr. or rhenish wine, tamarinds, &c. or if liquors will not stay, repeat diluent clysters, in small quantity, the oftener, as every three or four hours, charged with camph. after the manner of jul. camph.— Inwardly, give the tinct. rosar. made with an equal quantity of pulv. camph. & cinnam. & boles ex pulv. è chel. vel bezoard. & sperm. cet. aa. For the coma or delirium, blister the feet, legs, arms, &c. Cup and scarify the scalp about the occiput, and bathe the temples, forehead, or whole of the scalp with acet. camph. &c. if a diarrhœa attends, only keep it in good decorum; or if any icteritious appearance continues after the recovery, purge with tinct. rhab. and give boles of soap or sal. diur. with myrrh or the gums.

2. Observe never to bleed in fevers, when you see, by the icteritious colour of the eyes and skin, joined with a full labouring but soft pulse, that there is such a return of bile into the blood; for the bile so far dissolves the glue and elasticity both of the solids and fluids, that any evacuation by the lancet immediately sinks the force of both upon the encephalon, together with the patient: but the use of camphor, in all shapes, as a most potent antiseptic, with mineral acids, will be highly beneficial.

3. Besides the first delirium, that sometimes attends the beginning of this fever, and is symptomatic, or from the nervous consent which the encephalon bears with the stomach and abdominal viscera; after the second day, there is a true coma or delirium from the dissolved blood straying too deeply, together with the biliary juices, into the pellucid vessels of the cortex cerebri; the state of which you may, in a great measure, know, by the near related appearances of the conjunctiva and albuginea of the eye: and this distinction is the more necessary, because an emetic, that removes the former, renders the latter more fatal. This caution is likewise applicable to the deliria of many other fevers. But rarely blister in the increase of these fevers, 'till you see nature is sinking, or an original delirium invades; and then always begin from the feet or lower extremities.

§. 37. A *simple* fever, is properly a mere quickened circulation from some external cause or an impeded excretion, in a good habit without any aguish, inflammatory, or contagious matter

matter conceived in the blood; and consequently, one that soon ceases of itself, (for which reason 'tis called diary) by diluent liquors, rest, abstinence, and light recruitive nourishment, or by opening the first passages with a laxative, and the skin, in firm habits, by a warm bed, with other discretional management, conformable to the slight exciting causes (§. 16.), which the patient may point out. But such a fever, too long protracted or mismanaged, will soon, by the increased motion, generate a matter in the blood, partly inflammatory, and partly putrid, that will require again to be digested, and critically excluded, by the new or secondary fever, under a treatment that would have been very unsuitable to the primitive ephemera, which, at most, would hardly have required more than a moderate blood-letting, emetic, cooling purgative, or a clyster.

2. Here we may observe, that the aguish or albuminous lentor, though formed by a weakness or indigestion of the blood (§. 25.), is yet more peculiar to the serous, lymphatic and cellular systems, through which the juices are moved on more slowly by the force of the heart, and within which the aguish viscosity is urged to different depths, agreeable to its quantity and density, so as to cause intermittents, differing as to their times or periods and facility of cure: but to the former, we are nevertheless to add the smallest or anastomosing junctures of the sanguine arteries and veins (Physiol. §. 134.), which first make the principal stage or seat of the aguish no less than of the phlogistic lentor

in fevers; only as the first is bred and collected by a too languid circulation (§. 5.), and nestles chiefly, in the said systems, around the least sanguine vessels, by an increased action of which 'tis expressed, attenuated, and returned into the habit; so, on the contrary, the phlogiston is bred from a too quick or strong motion in the blood, collected chiefly in the arteries; from whence, being once removed into the small veins, it either colliquates, like pus, so as to pass the emunctories critically, or else so far relaxes its tenacity as to come near the loose, aguish, or albuminous lentor, which turns the continual, to a remitting or intermitting fever.

§. 38. The contagious or epidemical febrile matters (§. 29.), which are commonly received and exterminated by the skin, with or without exanthemata; the nervous fevers (§. 31.), that more particularly deprave or exhaust the spirits; and the gangrenous or colliquative matters, whether scorbutic or bilious (§. 35.), are all of them, both as to causes and effects, perfectly opposite to the coagulating or pleuritic lentor, that gives birth to true phlegmons and inflammatory fevers: but the matter of remittents and intermittents comes in as a medium betwixt both the former, and is convertible into either; as by an improper treatment with mere stimulants or hot medicines into a pleuritic phlogiston, whence painful and inflammatory fevers; so by a neglect or long continuance, it may weaken the habit, and by being long retained, acquire a scorbutic colliquative acrimony.

2. Thus

2. Thus an intermittant, that has been rather stifled than cured (§. 33), will often degenerate to a gangrenous acrimony, and then under corroborating circumstances, break out as a malignant or putrid fever, that borders much either upon the nervous or inflammatory kind, &c. On the contrary, as the matter of intermittents degenerates for the worse, by acquiring either a malignant acrimony or a phlogistic density; so the tougher lentor of ardent fevers often relaxes for the better, and brings the fever either to remissions or intermissions, that readily yield to the admirable cortex, whose power is then able to attenuate and exhale the matter.

3. Dr. Langrish of Petersfield, has shown us, by repeated experiment, that the febrile tenacity of the blood is greater in remittents and quotidians than in tertians, in tertians than in quartans, &c. so that some remittents equal or exceed some continual or less ardent fevers. And as thus the matter of a tertian will often turn semitertian, and the quotidian become a remittent, by hot medicines, or a too early use of the bark, unguarded with rhab. therefore 'tis best, in people of strength and full age, to bleed once, give vin. ipec. or a bole ex rhab. cum cal. and if the size or tenacity of the blood directs, postpone the bark for hauff. salin. till four or five fits are over, by which the matter will become duly relented to submit entirely to the dominion of the celebrated drug, without leaving any remains, prejudicial to the habit. This precaution ought more particularly to be regarded in those vernal intermittents,

that are often epidemical, and in a degree inflammatory among people of low, maratime regions.

4. But on the other hand, if, instead of the phlogistic density, autumnal intermittents seem to participate of the nervous, malignant, or bilious disposition, into which they sometimes entirely resolve; in order to avoid a consequent dropsy, or an atrophy that is either nervous or mesenterical, one ought always to enliven the cortex with camph. r. valer. serp. virg. g. myr. &c. or in a tight oppressed belly, to join rab. to interpose or rather prepare by bol. ex rhab. cum calam.

§ 39. Although the phlogiston or size we see in painful and ardent fevers, generally abounds so much before hand in the blood, that being joined with other exciting causes (§. 16.), it brings on the phrenitic, pleuretic, rheumatic, &c. fever; yet the most part of it is generated afterwards, by repeated accessions, from the violence of the fever itself, which it again proportionably heightens, unless the arterial forces, from whence it springs, be duly lowered by copious and repeated bleedings. Hence it is that volatile alcalies, cordials, and frequently even blisters, succeed so indifferently in the attenuation and removal of it; if used before the arterial forces begin spontaneously to abate, or have in some measure subsided, by the lancet and other evacuations. Again, the phlogiston or inflammatory size, that generates ardent fevers, like the arbumenous or aguish viscid obovementioned (§. 38.), may be conjoined with

with an epidemical or a contagious acrimony (§. 29.), taken in through the outer or inner cuticle; or else with an icteritious and colliquative transflux of the bile (§. 35.): whence the size and serum will often appear, in the first case of a greenish-blue, or a violaceous purple cast, only faint or dilute; as if a little of the laurel water, or a volatile alcaly had been mixed with it: but in the last case, they will either be almost absent, or of a yellowish green, with a treacle-like crassamentum. In both these cases, the bleedings, which are so necessary to cool and relax, in the advance of more ardent fevers, must be cautiously avoided; even though a coma, pleurisy, or a peripneumony, may seem to call for it: because here four ounces of blood sinks your patient more than forty, in a true phlogistic pleurisy, where there is much of a white or light-yellow coloured size; which last is always a good warrant for repeated bleedings, conformable to circumstances of the patient and complaint. In such cases of dilemma, draughts every three or four hours ex Tinct. Rosar. Cin. & Cort. P. in equal quantities, charged with vitriolic acid, have often miraculous effects, joined with camphorated blisters, and plenty of diluents.

§. 40. A due regard to this discrimination of primary and mixed fevers (§. 38, and 39.), with what has been said of their treatment in general (§. 34, and 32, ult.), may conduce greatly to a judicious and salutary practice, in a branch that no less nearly concerns, than largely calls for our advice; which we could wish

with those who generally ply them too much in one and the same old tune, would call oftener and earlier to their assistance; but jealousy and concupiscence are with the multitude insuperable pharisacons. For besides what we have said, in mixed fevers, a regard must be had to the kind of acrimony that joins the febrile lentor or size of continuants; as whether it be from an obstruction of the cutaneous, renal, or intestinal emunctories, separately or conjunctly; or some antecedent scorbutic, venereal, arthritic, or scrophulous acrimony, slowly bred in the habit; or lastly, some gangrenous dissolving acrimony, taken with the air and aliments, under the title either of epidemical or contagious; which latter, from its nature and tendency, may be subdivided into (1.) such effluvia as stop short, or exert their virulence in one stage or other of the mucous passages, through which the air and aliments take their course: thus we have epidemical coughs, with a sore or inflamed larynx, wind-pipe and bronchia, in different degrees, in which the excreted matter has more or less a crude, or a purulent appearance; or if the contagion has no affinity to those parts, it will often make its nest in the mucous cryptæ of the nares, phauces, pharynx and gula; of which you may see one example in Dr. Fothergill's essay on the gangrenous or epidemical fore-throat: or sometimes again the contagion will, like antimonials, pass dormant or inert by those parts, and yet exert a great force on the more exquisitely sensible villous coat

coat of the stomach and intestines, whence epidemical cholera's, diarrhœa's, dysentery's, &c.

2. But sometimes again (2.) the contagion shall pervade all those parts with little or no disturbance to them, till having penetrated the inmost recesses of the blood and lymph, it naturally inclines to be discharged by the skin, either insensibly by a vapour, which is the best, or else by a clammy and copious sweat (which was extraordinary in the pestilent sudor anglicanus, that appeared last among us in the midst of the 16th century); but more frequently it goes off, after a due degree of the fever, by exciting some kind of cutaneous eruptions, either scaly, serous, purulent, or gangrenous, according to the disposition of the juices and vessels in general (§. 3, to 24.), and of the insuperable inflammatory poison to be this way exterminated.

3. Thus, in the dry erysipelas and scarlet-fever, in a good habit properly treated, the exanthemata go off barely with a scaly exfoliation of the cuticle; in the swine-pox, chicken-pox, and often in the scarlet-fever and measles, (of children especially) the serous elevations being inconsiderable, turn dry and scale off in like manner. But in variolous and pestilent fevers, the natural and best extermination of the matter, is by laudable cutaneous suppurations; which the art of healing is to promote and prevent from a gangrene, by regulating the fever, with suitable raising or depressing aliments and medicines, conformable to the stage, habit, &c.

4. Here

4. Here the nature of the febrile matter, being no otherwise the object of our senses than by its effects, by which we observe it varies in different regions and seasons, it is to be generally learned by a diligent attention, and a cautious procedure in practice, on a number of patients, in which it will vary by a mixture, with anguish or inflammatory lentor, or kinds of acrimony above.

§. 41. From the distinctions we have before made of fevers in general, by the various seats, natures, and tendencies of their matter; thence, joined with their degree and length of continuance, either with or without remission or interruption, they may be usefully subdivided into the following kinds or classes: for either they are.

1. SYMPTOMATICAL, or secondary; where the fever arises as a consequence from some other antecedent distemper, or a violent symptom of it; as bruise, fracture, wound, abscess or vomica, foreign matters, poisons, pains, gout, gravel, &c. where the treatment of the fever can only be palliative, and its radical cure effected, by removing the first distemper, from whence it flows.

2. ORIGINAL, or primary; springing from some matter in the blood itself, either slowly generated within itself, as the anguish viscid, and the phlogistic lentor; or taken into its mass from without, by the air and aliments, under the name of epidemical, contagious, or eruptive; or finally a dead putrescent matter, unexcreted
by

by its proper emunctory of the skin, kidneys, intestines, or a spitting.

3. Both these capital kinds (n^o. 1 and 2.), are again either (1.) *continual*, advancing and declining in an even regular course; or (2.) they are *paroxysmatical*; i. e. interrupted, either entirely by intermissions, or fits of perfect absence; or else by remissions, or fits of abatement (§. 7.): and these either regularly, at equal or certain times; or unregularly, at unequal or unconstant times.

4. As for the CONTINUAL fevers, they may be subdivided in such as are either (1.) *simple*, arising but from flight causes, and terminating with mild effects (§. 37.); or (2.) *inflammatory*, arising from, or increased by, a coagulating or phlogistic size, productive either of pain in the more nervous and sensitive parts, pleura, periostia, joints, &c. or of anguish and oppressions in the less sensitive cortex encephali, lungs, liver, spleen mesentery, &c. (§. 30.). These, if they come to the height of their fatality in a week or fortnight, may be called (1.) *acute*; or (2.) *slow*, if they hold a month or longer; or *chronical* and (3.) *habitual*, if they exceed two months. The inflammatory fevers may be also divided in (1.) *regular*, advancing properly through their stages in the natural and usual way; or (2.) *commutable*, where the matter and symptoms degenerate either toward the anguish or paroxysmatical ones above. Or thirdly,

5. They are of those continual fevers that are *malignant* or *colliquative*, dissolving by a gangrenous acrimony the glutinous healthy texture

ture of the finest vessels and globular fluids (Vol. I. p. 147. and II. §. 8. and 16.); either under the title of *nervous* (§. 31, 32), or *bilious* (§. 35), or epidemically *contagious* (§. 40.), whether eruptive or not.

6. Fourthly, the *complicated* continuants, are those joined with some other distemper, of which they are no symptom or effect; or else arise from a mixed, aguish, phlogistic, or colliquative matter, conjoined either two or more kinds of them together, in divers proportions, or under different circumstances. For the *modus operandi* in these material causes (See Vol. I. p. 104, 153, 162.). It now remains for us to treat of the eruptive, and of the paraxysmatical fevers.

§. 42. *ERUPTIVE fevers*, are either *original*, from some virulent matter, received by the air, aliments, or contact (§. 40.), productive of a fever; or *symptomatic* (§. 41.), from matters generated by fevers, or other distempers antecedent, or neglected to be exterminated by the skin, kidneys, or alimentary tube; or lastly, from over spurring any epidemical or colliquative fever, that might otherwise have gone off in a liberal diaphoresis.

2. The principal of the first kind which deserve our notice, are (1.) those of the dry *erysipelatous* kind, particularly from over tenderness and laxity, both of the solids and fluids; in which the fever, however moderate, throws out eruptions about the third or fourth day; which promoted by the mildest diaphoretics, immediately relieves the restlessness, cough, anguish,

anguish, or oppression, and soon terminates the fever with a scaly exfoliation from the cuticle. These, from their appearance, are either *pillary*, with palid risings, somewhat like those from nettles; or bloom-scarlet, which spread to a considerable compass, and vanish in proportion.

3. Next (2.) those of the moist or *true erysipelas*, tending to ulcerate, with a more violent fever, often partly bilious, and vesicating the face chiefly: or else petechial, with *purple* spots, like flea-bites, but distinguishable by their having no white point in their center, coming out on the breast chiefly, from the fifth to the tenth day, but rarely and with more danger in the face. These presage worse, as they show a greater degree of gangrenous colliquation, by inclining to a livid, brown, and black colour. In both these a middle way must be pursued, by keeping the matter where it is, by mild diaphoretics, without over-heating it into action, or moving it towards the viscera by depletions, at the same time guarding the texture and cohesion, both of the juices and least vessels, Tinct. rosar. vel cort. P. cum ol vit. Tinct. cin. &c.

4. But (3.) the *milliary* fever that happens chiefly to child-bed women, and new born infants, (in which last it is generally so slight as to pass unnoticed, under the name of red-gum) from a peculiar ferous, or lacteal acrimony, tending to the skin, under the palid form of millet-seeds, whence it is named, or often reddish, and with a sickly smell, shows its
erup-

eruptions indeterminately from the fifth to the fifteenth day of the fever, which being arrived to their maturity, include a putrid ichor. It seldom happens to men, but from an epidemical contagion; and in all requires to be cautiously treated, like the former kind (n°. 3.) above, with jelp. camph. and other mild diaphoretics; aided with oily emulsions, sperm. cet. testacea, pulv. è trag. and papaverines, to palliate the acrimony and its irritation, &c. (§. 36.). Here nothing more laxative than the syr. ros. or manna, made a syr. with Tinct. rhei. vel. fen. can be trusted, either in the epidemical, purple, or the pale milliary kind; and the clysters must be only emollient, with camphor: for if the matter be repelled by cold, or thus solicited inwards, it is sure to bring apthæ upon the lungs or alimentary tube; whence a quinsy, peripneumony, a vomiting, or a gangrenous dysentery, that soon kill.

5. But in all these milliary fevers we must be cautious of opening a vein (§. 44. n°. 2.), unless in the very first attack, with a fulness (§. 13.), and a density of the habit (§. 8.). Emollient and diluent clysters here afford a good way of giving camphor, that offends the stomach, but thus may be repeatedly useful. But blisters, more or less, with plenty of diluents, are in these generally of service, and in most of them directly necessary (§. 44. n°. 4.). Haust. ex. Tinct. cort. p. f. j. with acet. camph. (made as the julep. è camph. only 3ij. to a pint, is little enough, as this acid restrains it more, and rarely imbibes above half a scruple of it) ij parts
alum

alum, gr. ij. or iij. nitre, v. or vj. with fyr. mecon. q. s. makes one of the most potent antiseptics, which is at the same time highly alexipharmic or diaphoretic, that pharmacy can produce. By this, with or without the acid, artfully dosed and timed, you may either fill the crude serous pock with laudable matter, or else turn the laudable pock into a dark gangrenous condition, by often giving it when there is no occasion: but in putrid, malignant, and epidemical fevers, that tend to no eruption, you can rarely do any mischief by it.—After these come the measles, small-pox, and pestilence; the two former of which we shall next consider.

§. 43. The measles and small-pox, though modern distempers, are very near relations, and invade much alike, in the manner of other originals (§. 33. n°. 3.), from a febrile matter; only herethe head and back are more especially affected, by a local fulness, in the aparatus or inflammatory stage of them. The eruption of both is also preceded with some sickness, or a vomiting and oppression of the stomach; only the rising spots of the measles break out sooner, after three or four days, so as to be upon the dry-turn, by the time that the pock is well out, or maturing, viz. on the seventh or eighth day. As the morbillious matter is not sanguine, or inclined to suppuration, but of a serous or lymphatic nature, leaving the habit about the seventh or eighth day in a dry scurf; so it more especially affects the lymphatic and cellular systems, principally in the head and

lungs, after the manner of a *corrysa* or cold: Hence the little or no abatement of the symptoms given by the morbillous eruption; and the troublesome peripneumony, that generally calls for the lancet and laxatives, on the eighth or ninth day, when they are on the dry turn. But the flea-bite eruptions of the small-pox are more rising, and give considerable ease or abatement to the symptoms; except that in the copious or confluent pock, there is a troublesome purging in infants, or a spitting in adults, which are hardly ever seen in the distinct sort: and from the ceasing of those discharges, with a return of matter to the blood, about the end of the third or maturative stage, i. e. from the 12th to the 15th day, a new secondary or symptomatical fever, requires to be treated as the morbillous peripneumony, by the lancet and laxatives, as the *infus. sen. vel. rhab. cum manna, &c.*

2. Now as both the measles and the small-pox often owe their malignancy to an involuntary infection in the autumn, by a complication, with an aguish or a phlogistic lentor (§. 33. n^o. 3.), condensed by the summer season, antecedent in one over dense (§. 8.) or full (§. 13.): therefore we advise every body to encourage the inoculation (of this otherwise modern ravager of mankind) by planting a more favourable vernal sort, after due depletion by the lancet, and a *bol. ex rhab. cum cal. vel infus. sen. &c.* in full habits; and an attenuation, by the bark and æthiops, in dense, phlogistic, and in nervous chacochemical habits. Thus the inoculated

lated small-pox, will have the advantage of near 100 to one, over that which comes probably at the worst season, in a bad or unprepared habit, and from the most malignant species.

3. The measles generally pass over, among the poorer folks at least, without much assistance from the apothecary, or any advice from a physician; for indeed they seldom want any, unless to forward them by cordials, or when the oppression on the lungs, at their exsiccation, calls for the lancet, blisters, or laxatives. As the purging in infants, or the spitting in adults, that attend the confluent small-pox eruption, abate the violence of the distemper; although they are symptomatical discharges, they must be only moderated under an excess, or even be excited if they flow not enough: so the first may be restrained within bounds, by a mixture with testacea & tinct. rhei vinos. & tinct. cinnam. given in frequent and little potions, or excited by a larger proportion of the tinct. vel syr. rhei. vel rosar. solut; and the spitting may be promoted by oily emulsions, with sal. c. c. tinct. myr. lac. amm. vel julep. è camph. flor. benz. & syr. balf. &c. But the treatment of excess in this discharge, you may best judge of from the extraordinary case which Dr. Wilmott gives in his father Mead's book de Variolis, in which the patient was reduced to a skeleton by a salivation, equal to one from mercury, that held above a fortnight. Here, from the eighth to the 12th day, instead of a maturative suppuration, a violent head-ach, dyspnæa, and languor of the artery attended; till about the end

of the time a strangulative quinsy invaded, and soon after was relieved by the said spitting, entering on the 12th day. He suffered nature to continue her drain, under a fluid nourishment and diluent liquors, and recovered his patient as one in a tabes; viz. by repeating the lancet, one in a week or two, to the third time, in a quantity not exceeding six ounces, with rhab. q. s. to purge at intervals (without which the body gains a hasty crude fulness), haust. salin. cum sp cet. and asses milk for the hectic; and finally corroborants, elix. vit. aq. spad. r. rhab. &c.

4 As the crude or crystalline pock requires forwarding, by rich sack-whey, with sal. c. c. confect. card. and blisters on the extremities, by the fifth or sixth day from their eruption; so the bloody, whether from the kidneys, intestines, or mouth, require to be restrained by min. acids, with tinct. cort. laxatives, and sometimes the lancet, with blisters. As for lenitive purges, in the close of these and most other fevers, they serve in part to exterminate any relicks, but more especially to prevent a too sudden and crude fulness, by which those whom these fevers have greatly impoverished, would otherwise suffer, in their head and nerves, by a foolishness or stupidity, or in their whole habit, by a scurvy or a dropsy.

5. Dr. Huxam of Plymouth, whose good judgment and extensive practice have enabled him to oblige the world with some useful writings on these heads, judiciously observes in the latest of them, that the quantity and condition

dition of the blood, either poor or dense, with an anguish or inflammator lentor, or a scorbutic acrimony, have a considerable share, in conjunction with the epidemic season and situation, towards determining and changing the pock to be either distinct or confluent, crude, gangrenous, or bloody. These, joined with an intermittent, are to be treated with the bark. Those that come with a pannic, and run to the tenderer internal epithelium of the lungs and alimentary tube, are to be timely solicited to the skin by blisters and fomentis. The black, gangrenous pock calls for the bark and mineral acids, after having first removed the dispnæa or the constipation of the bowels, as above directed, when they attend. The secondary or purulent fever, attacking the head by delirium, &c. is a good warrant for the lancet and lenient purgatives; as that which comes before the eruption is for clysters and papaverines. Also in many slow, seemingly nervous fevers, where nature is unable to throw out a critical discharge by the emunctories, we have experienced that lenitive purges will make a sort of artificial crisis, to the great comfort of the lingering patient: but it is on another account (§. 40. n^o. 2.) they are often so useful in the beginning of epidemical, contagious, and bilious fevers, viz. by seasonably excluding a good part of the fomes, while nature can well sustain them. Sudorifics are never to be used in the beginning of any but pestilent fevers, and to promote those sweats which are critical and relieving, after the height of epidemic malign-

nant, or inflammatory ones ; and even then the mildest, ex acet. camph. & aq. f. alex cum syr. de mecon. with thin diluents and warm covering, are the best.

§. 44. Eruptive fevers being all (§. 42, 33.) naturally of the colliquative kind, (unless when conjoined with a lentor, either aguish or inflammatory ; the first of which they dissolve soon, and the other later, but with more violent symptoms) they will in general come under the same method of cure ; viz. by moderate depletions in full (§. 13.) and dense (§. 8.) habits, at the first onset, or inflammatory stage of them, by lancet, emetic, or mild purgative, &c. or else omitting them in the relaxed (§. 4.) and impoverished (§. 25.), go on with sack-whey, more or less rich of the wine ; with suitable cardiac and diaphoretic medicines, confec. card. | pulv. cont. | julep. vel acet. è camph. | tinct. valer. vol. | aq. alexit. &c. in draughts and boles, so dosed and timed, with diluents, as to keep the circulation above nature unexercised, but below any degree of sweat.

2. But be cautious of your bleedings, or depletions, as they are here not curative of the fever, only calculated to abate their first or inflammatory stage, which may be known from their tension or resistance of the pulse, and tenacity of the blood ; and therefore rarely to be practised after the first attack, but under the most pressing symptoms, and in deliberate consultations, in which sometimes they are ordered with success, under management of those who
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are the most skilful and eminent; and particularly for relieving the encephalon or lungs in the maturative and declining stages of the small-pox, measles, &c.

3. So opiates are, in general, equally to be suspected here, as they increase the laxity of the arterial and nervous systems, with the already peccant colliquation of the fluids, whereby such an erroneous straying of the cruor ensues, into the pellucid and fine cellular system of the encephalon and lungs, as soon lays the patient into a sleep, from which he will never awake. However, if the tone of the vessels, and texture of the fluids be duly guarded by mineral acids, with tinct. cin. cort. p. &c. Papaverines may be then advantageously given in the evening to abate the painful irritations, coughs, watchings, and uneasiness, which increase in these, and in all continuants, about the close of the day; and arise to a more considerable degree, in tender and nervous habits.

4. Blisters rightly managed, and frequently cupping, are of great use in all these fevers, not only by dividing or digesting the lentor, with which they are often complicated, but more especially as the former are a lasting spur to the diaphoresis, and naturally derive the malignity towards its proper emunctory, or even powerfully remove it, from the entrenchments it may have made, in the least vessels and cellular fabric, which organize the encephalon, lungs, and abdominal viscera; and therefore a timely use, and a moderate repetition of them will rarely fail of their salutary effects. So also will

the stimulative epithems, plasters, &c. in which camphor must make a principal ingredient.

5. But as nature, or the fever itself, is here the principal curative agent, she must not be too hastily spurred by these (n^o. 4. sup.), nor by cordials, beyond her salutary and moderate pace; up to which she must be raised by them, with light good nourishment, in the malignant or ferous kind of the small-pox, that lag behind a laudable suppuration, for want of a due strength of the solids, or a consistency in the fluids: as on the contrary, she must be restrained by depletions, papaverines, and the tinct. cort. cum sp. vitr. when the sanguine or phlogistic sort run together directly like echymoses, in the very onset of their first stage, so as often to be gangrenous by the fourth or fifth day, and soon after are either productive of a colliquative and fatal hæmorrhage, through the renal or alimentary passages, that bids defiance to all art; or if there be a lucky escape, 'tis commonly with some gangrenous or incurable ulcer in the lungs, viscera, or other part of the body; all which misfortunes come oftener from unseasonably neglecting the over fulness and density of the habit (which are the chief heads to be regarded towards inoculation (§. 13. §. 8.—§. 4, and 25.)), or by urging them with too keen spurs, than from any extraordinary force in the epidemical or infecting matter.

6. For reasons above given (3.) you will never venture upon opiates in children, or lax habits, before the small-pox are maturely out, nor when the lungs are suffocatingly oppressed,

or

or the encephalon comatous, or delirious: for only by the use of paverines (with discretion, as above), epithems and good warm covering to the feet, with an emollient clyster every other day, both the restlessness, and the opression of those important viscera may be happily relieved. To this last treatment, with opening a vein, will yield the delirium that comes three or four days after the variolous eruption; in which the infus. sen. may often be usefully given. Strong children may bleed at first, by leeches on the temples, or otherwise; but in the weak and tender, which have often convulsive motions, a little before the eruption, it may have the most fatal effects by withdrawing the matter, which that commotion denotes to be now advancing on the skin: and so too, in robust or adult youths, the early opening a vein once, twice, or thrice, will often raise the oppressed circulation, throw out a mild eruption, and prevent a delirium, or worse accidents. Whereas the measles call strongly for cordials, rather than depletives and coolers, in their beginning; and require the lancet at the turn of the distemper, with lac. ammon. | papaverines, myrrh, oily emulsions, &c. to relieve the suffocative peripneumony about the ninth or 10th day, which often leaves a destructive ulceration in the lungs, as well as the small-pox.

7. In these fevers, volatile alcalies are not mischevious, but by an excess, in dissolving the gelatinous texture of the fluids, and by the same power weakening the spring of the solids; since Dr. Pringle has now ingeniously cleared them

them from any other putrescent quality, and showed they are antiseptical on dead substance. But observe in living animals, there is a necessary distinction betwixt putridness and purulency; in promoting which last, sparingly used, and with diluents, they have, in general, a peculiar tendency, by which they may be of great use in the crude small-pox and pestilent gangrenous eruptions, that want laudable suppuration.

§. 45. What has been now said of the small-pox (§. 42, 43, and 44.) might suffice for the experienced and intelligent; but for the sake of those who are only entering upon the practice of our healing art, in so frequent and weighty a distemper, we shall descend to a description more minute and historical.---The small-pox are then either (1.) *epidemical*, depending upon a particular constitution of the air, generally seizing, at the same time, almost all such as have not been affected with this disorder before; or (2.) *contagious*, being communicated, by the morbid effluvia that arise from the affected patient, to others within the sphere of their activity, whose bodies are susceptible of their impression and influence. They invade in any season of the year; but especially in spring and summer. In autumn they are generally of a milder constitution, and upon the decline; but the sooner they appear in the winter or spring quarter, they are of a more malignant nature. They principally seize children, more than aged persons, and are of two different sorts, viz. the *distinct*, which stand apart one from the other; and the *confluent*,

fluent, which run one into the other: the latter of which are attended with greater danger, as having a variety of symptoms, which are not found in the distinct sort; and of a more perplexing nature. The course of the disorder, in both sorts, consists of four different periods, viz. the *invasion*, *eruption*, *maturation*, and *exsiccation*; all which are sooner run over in the distinct than in the confluent kind.

2. When either *invades*, the patient is immediately seized with a shivering and shaking, followed by an acute feverish heat, attended with a white tongue, thirst, loss of appetite, drowsiness and heaviness of the head and eyes; a sharp humour irritates his nose, on which account he often sneezes, and his eyes itch, and are waterish. His eye-lids appear swollen, he vomits frequently, has a dry cough, and difficult respiration; he feels violent pains in his head, back, loins, and at the pit of his stomach, if it be pressed with his hand; his pulse is quick and high, his countenance flushed and florid, his urine sometimes, as in an healthful state, but generally crude and turbid, and his blood at this time extravasated by the lancet, appears pleuritic or fizy. Convulsive fits in children now prognosticate an immediate eruption; unless they arise from the difficult breeding of their teeth. They, who are affected with the distinct pox, have a great propensity to sweat, which is peculiar to this sort; and in the confluent, the eruption is usually preceded by a looseness, which is seldom or never to be observed in the distinct. The symptoms, now
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mentioned, increase from the first invasion, and continue 'till the eruption; but with unequal vehemence, in the two different sorts: for, in the distinct, they are of a milder nature, but in the confluent, the fever, sickness, restlessness, and vomitings are very violent, and generally remain two or three days after.

3. The *eruption*, in the distinct, commonly happens upon the fourth day, after the first invasion, and seldom later; but those of the flux-kind make their appearance on the third, or very often sooner, but seldom or never on the fourth, unless it be when they are retarded by violent pains, or other extravagant symptoms that affect the patient. (1.) In the *distinct* kind small flea-bite pimples now appear here and there, especially in the face, neck, and breast, and gradually over the whole body, which daily increase in height and bigness. At first they are red; afterwards they become chrystalline, by degrees obscurely pale, and then more yellowish at the top, 'till the time of their full maturity. By these the skin and flesh adjacent are inflamed with great pain, and tumified. The eye-lids now become so swollen, that they close, and thereby the patient is deprived of sight, which generally happens on the eight day; which is therefore to be particularly observed in this distinct sort. Afterwards, in proportion to the number of pustules, the hands, fingers, and other parts are seized with an inflammation and tumour, which diminish on the eleventh day; for, at this time, the distinct are at their full maturity. From thence,

thence, they gradually dry up to the fourteenth or fifteenth day, when all, except those on the hands, fall off. After the pustules are gone, scurffy scales arise, which commonly leave some impressions or pits behind. But (2.) the confluent, at the time of their eruption, appear sometimes like an erysipelas, and sometimes like the measles. In this sort, the pustules do not arise so high as in the distinct, being small both in the face and trunk; but become larger, the nearer they approach to the extremities. In the face, they are connected with, or run into one another; insomuch, that it appears as covered with a red bladder. After the expiration of the eighth day, the skin, which before was smooth, gradually becomes rougher, and the pustules turn of a more dusky or dark colour, 'till the time of their maturity. After this, they dry and fall off, in respect of time, according to the severity of the pox; for, where they have been violent, the face is not altogether freed, 'till after the twenty-third or twenty-fourth day. When the pustules have fallen away, the scurffy scales succeed, which are here of such corrosive nature, as to leave deep pock-holes, and often unseemly scars, or contractions and seams of the skin behind them.

4. In both sorts, the fever is at the highest from the first invasion to the eruption, whence it gradually declines 'till the maturity, and then totally vanishes; but, upon the exsiccation, a secondary or new fever begins to appear, particularly in the confluent-kind. The symptoms,

toms, which in the distinct-kind, affected the patient at the invasion, immediately cease upon the eruption; but, in the confluent, although they be more moderate, they continue several days after. When the pustules of the confluent sort begin to dry, a salivation arises in adults, and a looseness in children. The former is observed in such, a constant attendant upon the disease; but the latter has not been so generally observed.

5. The symptoms of most dangerous consequence that arise in the course of this disease, are (1.), if on the eighth day in the distinct kind, the swelling and redness of the face and hands, as also the sweat, which all along perspired from the patient, cease on a sudden: if upon this he becomes delirious and restless; and if he urines often and little at a time; for these prognosticate immediate death. (2.) If, in the confluent, the salivation ceases entirely on the eleventh day, without a return, and without a continuance of the swelling in the face, or any manifest appearance of a beginning, turgency, or swelling of the hands. (3.) If the matter, which should be discharged by salivation, becomes so viscid that it cannot be evacuated; upon this, there is danger of suffocation, from the difficult respiration, and uneasy deglutition that arise; in most of which cases the patient quickly retires to another life. (4.) If either in the confluent or distinct, the fever be violent through the whole course of the disease; if there be a difficulty of respiration, a phrenzy, or coma; if there be purple, livid,

livid or black spots, either between or upon the tops of the pustules, and if upon their eruption, they immediately disappear. (5.) If the matter contained in the pustules, be of a gangrenous nature, or if a mortification arises in the parts. (6.) If there be an hæmorrhage of the nose, an immoderate and sudden flux of the catamenia, an hæmoptosis, bloody urine, a micturition, or total suppression of urine in young people. Lastly, if the pustules on a sudden come flat, and if a looseness arises in adults.

6. The prognostic rules, for judgement in this disorder, follow: the disease in itself, is not of a very malignant nature; for if there be no ill management, it generally runs through the different periods (n^o 2. and 3.) without any considerable danger, and commonly terminates in health; but sometimes unexpectedly in death, or another disease. In the distinct-kind, the eighth day, and in the confluent, the eleventh are principally to be regarded; for according to the nature of the symptoms that arise on these days, so must be the determinations made in respect of the life or death of the patient. The kind and degree of malignity in the disease must again be determined according to the appearance of the pustules in the face. If upon the invasion, the symptoms be not very violent, we have reason to expect, that the other different periods will be favourable, and vice versa. For the most part, the slower the eruption, the more favourable we find the disorder. So the fewer, softer, rounder, more pointed at the top, more distinct, larger, whiter, and

and (in the course of maturation) the yellower, and the more remote the pustules are from the face, the better are the events to be expected. But the more they are in number, especially in the face, the less in magnitude, the sharper and more ichorous their matter, the more they flux or run together, the bluer, browner, and blacker they look, and the sooner their eruption, they are so much the more malignant. The hotter, redder, and more tumid the interstices between the pustules are, at the time of maturation, the greater are the hopes; but the paler, browner, and more flaccid they appear, so much the worse; for, upon these, a quinsy, or a mortal peripneumony usually invades the patient. This disease is less dangerous in women (if not pregnant), in children, and in such as are of a soft, phlegmatic and lax disposition of body, than in old, dense, or rigid people, and such as have been accustomed to hard labour. If the external habit be only affected, the event is less dangerous; but if the jaws, gula, intestines, stomach, or other internal parts be seized by the pustules, the danger is the greater.

7. The disorders or bad effects this disease leaves behind, after it has run through its different stages, are these that follow; viz. deep pits, or pock-holes, contractions of the skin, and unseemly scars or seams in the face. Pearls, in the cornea, or a weakness or inflammation of the eyes; as also dimness of sight, and often total blindness. Convulsive, epileptic, and apoplectic fits; malignant tumours and apoplems,

items in several parts of the body; an asthma, pleurisy, and peripneumony or inflammation of the lungs; a phthisis or consumption, and very often a cachectic, or ill habit of body; by means of which, the patient is rendered unhappy through the whole remaining part of his life.

8. If we enquire after the original of the disorder, we find, that it is but a new disease, or of a late date; for we cannot discover any descriptions of it transmitted to us by any of the ancients, which may be taken as an undeniable argument, that it never appeared among them. For it cannot be supposed, that they, who were so very diligent in making observations on other diseases, should not leave us any history of this, which now makes such a formidable appearance in the range of distempers. Besides, 'tis evident, that, at this day, 'tis entirely unknown in several parts of the world; and that, in the West-Indies, it was never heard of, 'till the Spaniards conveyed it thither some few years ago; at which time the infection was of such dismal consequence, that (the proper method of managing this distemper not being known) whole nations fell a sacrifice to its fury. The first, who delivered us any account of this disease, were the Arabians, whose observations, both as to the history, cause, and method of cure, are so accurate and just, that our modern authors have made but small improvements in any of those parts. Of this you may be convinced by the perusal of Mesue, Razes, and Avicenna;

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whence the places usually produced from Hippocrates, Galen, and Celsus, will appear so very foreign to the purpose, as to need no particular refutation.

§. 46. Since the general and most rational treatments of the small-pox may be collected from §. 42. and the following, therefore we shall now only add to the preceding history (§. 45,) a word or two upon *inoculation*, and upon the *antidotal* or preventative cure; which last is proposed by Dr. Boerhaave, the late eminent professor in the university of Leiden. This truly learned and judicious gentleman, considering the small-pox as an acute and continual fever, whose pustules are only a critical discharge of the morbid matter, esteemed it no ways necessary to wait the different periods of the disease; but, upon the first invasion, recommends immediately proper evacuations, such as venæsections, vomits, and laxatives, as also the cooling regimen, prescribed in other acute diseases, by which he aims to prevent the eruption of the pustules, and the other consequent stages. But, with all due deference to the judgment of so great a man, this method seems mal-practise, as it exposes the patient to many and prodigious hazards; first, because there is a sudden and contrary motion introduced in the fluids, entirely opposite to the directions of nature, and the genius of the distemper; which procedure has generally been observed to be very detrimental to the human frame, and always disallowed by the masters of our art. . For since physicians are the assistants of

of nature, it is their business to support, and not to thwart her in her operations, unless we find, that they tend either to the destruction or ill habit of the body. Secondly, because, by this method, the patients are subjected to repeated assaults of the same disease. For since there is here a latent seminium of the pocky matter, in the solids and fluids of the body; and since 'tis impossible to think, that there can be a due separation and discharge of it by this method, the patient must unavoidably be liable to the attacks of this disease, whenever the particular constitution of the air, in which the small-pox is epidemical, happens to be predominant; or whenever the disposed patient is within the sphere of activity, possessed by the contagious effluvia that arise from an infected body: for, supposing the same causes to be acting with the same force, and under the same dispositions of body, it necessarily follows, that the same morbid effect must constantly be produced. Now the learned Dr. Mead's late treatise on the subject shows, that persons are not absolutely exempted from catching the confluent kind of this distemper, altho' they have had the distinct; and that, even after both, a person may have a variolous fever, either with a few, or with no eruptions: and consequently (by §. 33, n^o. 3, before advanced) the person thus treated, will be only subjected to a worse kind of the distemper, unless a specific anti-dote could be found to throw out the matter insensibly (like the cortex for intermittents), without causing cutaneous eruptions.—Dr.

Lobb assures us, the æthiops minerale will have this effect, giving a dram of it every four hours, to the quantity of an ounce, or upwards; and in a less proportion, that it either prevents infection, or procures the mildest kind of the distemper; which we cannot vouch for upon our own experience. But we recommend it, or the cinnibar of antimony, to relieve the patient, sinking under the violence of the confluent kind; namely, when spitting is stopped, and the swelling of the face is abated; and when a new fever arises in the beginning of the exsiccation; for which a *mercurial ptyalism* was recommended, and practised by the late learned and ingenious Dr. Pitcairne. That this may be of very considerable service, is plain and obvious; in that it is the very method pursued by nature: in that a considerable discharge is hereby made: and in that the tumour of the face is again raised and continued for a due time; the advantages resulting from which, are easily discoverable by the history of the disease (§. 45.).—However, this is a method only to be used by the judicious, and those who know how to govern both distempers and medicines, according to the just rules of art; but is never to be put in practice by ignorant practisers, with whom it will be only a sword in a mad man's hand, carrying along with it immediate death and destruction. The method of purgation, practised and recommended by the celebrated Dr. Freind, Dr. Mead, &c. on the same occasion stands firm on experience, supported by matter of fact, than which we cannot have a more substantial reason.

2. We now come in the second place to propose the *method of inoculation*, for mitigating the disease. In the eastern countries, and such as are very much exposed to the influence of a hot sun, the small-pox being generally epidemical, is also very malignant, insomuch that vast crouds are yearly swept away by their violence. This has excited all persons, both learned and ignorant, to practise a variety of ways, that they might with more safety and expedition, either curb or prevent their destructive influence. At last, either by chance, deduction of reason, or experiment, they happily fell in with the method of *inoculation*. The author of this is not transmitted down to us; but there are several who lay claim to the praise. That it first proceeded from some of the populace, who were neither men of fortune, character, nor learning, seems very probable, in that it appeared in the world, without the least recommendation from any of the learned, and met with very considerable opposition from the rich. In several parts of Greece, the vulgar had it practised upon them; and from time to time it prevailed more and more, 'till, at last, it was approved of and received in Theffaly, and the adjacent parts. The Turks, at first, declared very much against the practise; but, at present, convinced by the consequences, they readily admit of the operation, and are as industrious in giving it the due recommendation it deserves. The Italians also, being apprised of the method, and of the success consequent

upon it, constantly employ their operators in an epidemical season, and thereby prevent a great number of inconveniences that might otherwise ensue; and to come nearer home, we now have the happy advantages of inoculation, very well attested by the whole body of the learned in our faculty, throughout the British dominions. The method of the operation, as it is practised in Theffaly, Constantinople, and Venice, is as follows: in the beginning of winter or spring, when the small-pox happens to be epidemical, a proper subject is chosen, from whom the pocky matter is to be taken, and this is generally a boy of twelve or fourteen, or a youth, who is affected either by contagion, or the disposition of the air, and labours under that pox which is of the distinct kind. Some of the pustules upon his legs and thighs are opened on the twelfth or thirteenth day, at which time the pox are at their full maturity. The pus is pressed out into some small vessel, which has been well cleansed with warm water: this is covered and kept warm in the bearer's bosom, 'till such time as 'tis conveyed unto the person, upon whom the operation is made. After his body has been duly prepared by the directions of a judicious physician, according to his particular constitution, and the nature of the disease, which is to be transplanted (§. 43, n^o. 2.); he retires to his chamber, which is ordered to be kept neither too warm nor too cold, and there waits the performance of the operation. After all matters have been duly adjusted, the operator pierces
cross-

cross-ways, or obliquely the muscular parts, particularly in the arms, legs, or thighs with a lancet or three-edged needle, 'till such time as the blood flows, and seperates the skin from the parts beneath; into these wounds the operator drops a little of the pus, which all this time has been kept warm, takes due care to intermix this morbid matter with the flowing blood, by the assistance of some pointed instrument, and immediately covers the wounds with half a nut-shell full of lint, or some such concave thing, and fixes it thereon, with proper bandages, for the space of twelve or fourteen hours, in order to prevent the cloaths or any accident from rubbing it from the parts, or from wiping away the pus, before it has entered the vessels, and intermixed with the mass of blood. It has been observed, that almost all, who undergo the operation, have the pox: and that those few, who have escaped them upon inoculation, have laboured under them, when they have been epidemical: but that those, who have had them by the transplantation, have never after been affected with them through the whole course of their life. The *regimen* prescribed after the operation of ingrafting, is, as follows: the patient is ordered to be confined to his chamber, and to keep his bed. His diet, through the whole course of the disorder, is adjusted according to the nature of the disease, the different temperament, the constitution, and other circumstances of the patient. He is directed to abstain from wine, and all other things that are apt to

inflamm the blood, not only during the several periods of the disease, but also for some time after. In Constantinople and Venice, they religiously forbear the use of eggs, flesh, and broths, for the space of twenty-five or thirty days. Some, who have been obstinate in giving small regard to those directions, by indulging themselves in unallowable liberties, have thereby been exposed to a variety of dangerous symptoms, which have sometimes proved fatal, viz. violent hæmorrhages, difficult respiration, phrensies, deliriums, peripneumonies, stranguries, bloody urine, fluxes of the catamenia, diarrhæas, dysenteries, and the like; all which were the consequences of their irregular conduct, and no way depending upon the real genius of the disease, nor the operation, which always renders them much less mischeivous. For thus the propensity to vomit, the restlessness and the pains affecting the loins, sides, back, and head, were so trivial, that small notice were taken of them; and the whole course of the disorder, raised by the method of inoculation, has always been observed of a much shorter date, than when it has appeared in a common way. The parts, constantly affected, are the places where the wounds were made, and the morbid pus instilled, in which arise pustules by maturation, filled with a sanious, but not a purulent matter, as in the common sort; and sometimes aposthems, which speedily tend to suppuration. The number of the pustules ensuing upon this operation are but very few, seldom or never exceeding above an hundred in number,

ber, and these always of the distinct kind. Sometimes they are observed only upon the places where the incisions were made ; so that the face has generally been left entirely free. After the maturation, they constantly have been observed to dry up in a very short time, and are also attended with this particular advantage, that after their falling off, the scurfy scales that ensue are not of that sharp corrosive nature, which is found in the disorder, when raised in the common manner of infection, from whence the deep pock-holes, contractions of the skin, unseemly scars, &c. consequent upon this distemper, take their original : for no one has been found any way pitted, or otherwise disfigured, upon whom the inoculation has been performed. Neither are the patients liable to any of the unhappy disorders that so sadly affect others, after the disease has run through all its stages ; such as the weakness of the eyes, pearls, blindness, diseases of the head, cachectic habit, and others already mentioned. Besides all these, there is another advantage, viz. that it always is attended with desired and surprizing success, from the first introduction of the method, 'till this time. For there has not been any constitution of the air, season of the year, temperament, age, or sex of the patient, in which the inoculated small-pox have been known destructive. These, being really matters of fact, may be sufficient encouragement to all, especially for children and the fair sex, to endeavour to have this method promoted and practised throughout the kingdom ; as also to physicians,

ficians, surgeons, and apothecaries, to direct their friends and acquaintances to encourage the operation; to the advantage of which, they may be eye-witnesses in our London small-pox-hospital.

§. 47. Although persons are rarely affected twice or oftener by the small-pox or measles, 'tis very probable, that a seminium of them, or of such like contagious fevers, is often conjoined with those which we call *erysipelatous*; where pains, with thirst, a restless-anguish, and vesications of the skin, either pustular or gangrenous, are constant attendants. In this we may be confirmed, if the fever is, at the same time, epidemical, and the blood little cohesive; which will be an indication for using the mild diaphoretic method (§. 42. n^o. 5.) with julep. camph. haust. salin. testac. cum sperm. cet. &c. But if the erysipelas appears to arise from an excited plethora (§. 16.) or an habitual relaxation with a scorbutic acrimony, it may, in the first case, be safely restrained by the lancet, with laxative or cooling purgatives; and in both the attacked part may be corroborated by restrictive-attenuants, acet. camph. | tinct. stypt. helvet. | alum. rup. cum acet. camph. &c. | And in the scorbutic sort, rhubarb purgatives at due intervals, with the cortex as an alternative, joined either with a mineral acid or a volatile alcaly, according to the prevailing acrimony, will be of considerable service. But never urge, even mere diaphoretics, in these fevers, up to an exagrating sweat; and be particularly cautious of the lancet, when you find the pulse in them
to

to be labouring but soft, and with a bilious appearance of the skin.

Of Remittents.

§. 48. The last capital or considerable class of original fevers we shall speak to, are those before distinguished by the title of *paraxysmatical* (§. 41. n^o. 3.); and these either (1.) remitting, or (2.) intermitting: in the former of which, we have remarked, that the febrile lentor has an intermediate tenacity, betwixt the tough phlogistic size of continual ardents, and the more loose or albuminous viscid of intermittents; by which, these fevers are very liable to become, either truly inflammatory or aguish. For thus epidemical continuants will, towards their height, often be attended every day with a chill, or a remarkable abatement of the fever; which denote, that it will be either soon an intermittent, or else of a very long continuance, if not assisted with the cortex. So, on the contrary, an intermittent may, by heating medicines, with an abuse of the lancet and purgatives, in an exhausted habit, be turned to a bad remitting or continual fever; in which our judgment by the urine becomes reversed; as the turbid hypostasis, that denotes concoction and improvement in original continuants, is here only a sign of crudity and stubborn violence; but a clear redish urine, or a little brick-dust sediment, proclaims a cure from the bark. A *remittent* then has a remarkable chill or abatement of the fever periodically, either every or every other day, at distances equal or unequal;

unequal ; generally of a stubborn disposition, and inclined more towards acquiring the appearances of a bad, nervous (§. 31.) or a malignant (§. 41. n^o. 5.) continuant, than to form a salutary crisis. Here I have raised the patient from a cold dead posture (with a despaired-of stupidity or coma, unaffected by blisters) in a very wonderful manner, by boles given every four or six hours ex conserv. flav. aurant. hisp. 3j. ext. cort. p. dur. vel mol. mj. ad 3ss. cum haust. salin. camphorat. i. e. secundum morem julep. camph. p. p.

Of Intermittents.

§. 49. The latter class of paroxysmical fevers, (§. 48.) are those which leave the patient tolerably well, or without any fever, for a considerable interval of time, which denominates them *intermittent*: and that either (1.) *quotidian*, if the returns are every day ; (2.) *tertian*, if every other day ; or (3.) *quartan*, if the fits invade every third day from the first : but if the fever returns twice within any of those spaces, the name of *double* is added to either of the former. . But the season and complication also make a considerable difference in them ; those that come epidemically, and in autumn, being much more stubborn and degenerative, than such as are merely habitual and in the spring. Nor is it unfrequent for the aguish matter to settle itself either in the head, lungs or mesentery of persons that are weak, nervous and hippish ; so as to form a local or anomalous intermittent ; in which you will have a variety
of

of periodic pains, and other polymorphous symptoms, that grow worse by venæsections, purges, or any heating medicines; but readily yield to the cortex, after they have lain undiscovered, and insuperable to other methods for half a year running. But in such cases, as Dr. Mead judiciously advises, rhubarb ought to clear the first passages, and often join in some proportion with the cortex itself; which, in these nervous cases, is also often to be assisted by an addition of myrrh, &c. (V. §. 48, ult.).

§. 50. As for the regular *uncomplicated intermittent* (§. 49.) it is in effect an unconnected chain of short continuants, which, like other regular fevers, suddenly invade, increase to their height, take their declension, form a partial or imperfect crisis, and make an end all within a few hours; from an albuminous viscid, fluctuating and slowly collected in the anastomosing capillaries of the arterial system, chiefly in the pulmonary and cutaneous ones, with those that belong to the dura mater of the encephalon, and its vaginal extension over the spinal medulla. There forming a gradually increased resistance to the heart, and to the passage through the lungs, the motion of the blood slackens with the whole nervous, cutaneous, bilious, salival, and all other secretions; except the mucous or viscid, within the alimentary passages, which are now considerably increased. And although we cannot imagine with his imperial worthiness Dr. Swieten, whom our great Boerhaave deservedly recommended to fill his place, as *Æsculapius* for the day,

day, that this extends, even through the minute fabric of the encephalon, into the nerves themselves; yet it is highly probable, that it affects the whole nervous system, after a peculiar manner, by its stimulus, acting on the fine epithelium and sentient fabric of the stomach, alimentary and arterial linings, in the same manner as cold, or any other stimulus does, by the outward skin; since the chill is only apparent or seeming to the patient, while his flesh is really several degrees hotter than in health, to the test of a good thermometer, or a fine temperate hand.

2. But whatever its operation may be in the vessels, whether nervous, spastical, opilative, or all together, we observe in one hour a very great change from it, in a patient that but 20 minutes before appeared chearful and perfectly well: for about 15, 18, or 20 minutes, before the fit, he is surprized (1.) by an undescriptive qualm, that is soon followed with yawnings, weariness, cold-chill, thirst, and a sickness or load at the stomach; the breathing labours, and the pulse falls much, both in its strength and magnitude; the face looks pale, while the nails and fingers ends are livid; a heavy pain is felt in the head, back, and loins, with a stiffness in the joints: soon after these (2. a dry or feverish heat gradually advances throughout the habit, which increases the head ach into a sort of giddiness, while the breathing and pulse now grow stronger, the thirst increases, and the little urine that is made appears commonly of a clear red, as in the height

height of a continual ardent, to which this part of the fit answers: at last (3.) the fever gradually declines and goes off, with more or less of a sweat, leaving a soreness in the habit, a lateritious sediment in the urine, and an increased weakness throughout the whole nervous, arterial, and even chylicative systems.

3. Here the first stage or cold-fit (n^o. 2.) will hold an hour or more, and the others in proportion, according to the greater quantity and tenacity of the albuminous matter, with its complication, habit of the patient, ingesta, &c. until the blood is so far collected in the venal system, that its pressure makes a stimulus strong enough upon the right side of the heart, to break through the pulmonary oppilation; and then passing on to the left, enables this also to raise the pulse and fever sufficient to remove general stagnations for that time. But as the hot-fit (n^o. 2. 3.) continues only long enough to digest a small part of the aguish matter, sufficient to turn the balance only for the present, and cause an imperfect crisis, therefore the original fomes soon after recruits, and retires to its primitive quarters, where the blood has least momentum; where by renewing the resistances again to the heart, and to the secretory action of the encephalon, it causes a periodical return of the intermittent as before.

4. How far the nervous consent of the stomach, always loaded with the aguish viscid, may be concerned in causing the cold-chill and other symptoms in this disorder, we will not pretend to say; but that it cannot but be considerable,

considerable, seems to follow from an assertion of the late learned and experienced Dr. Hall, of the Charter-house, upon whose veracity, in the experiment, I believe we may safely depend : viz. that he had often known a perfect cure made in these fevers, by the mere insipid, earthy and ligneous remains of the bark, after all its bitter, resinous and gummy parts had been extracted, by proper menstrua ; in which case, I believe most judges will allow, it could not exert any immediate action beyond the first passages, whose nervous papillæ, with those of the skin, we see easily affected by the minima stibbi, stimulating them to a vomit or a sweat, while other parts are unaffected by them. Also the power which the said nervous consent of the stomach has to induce sleep, and abate the circulation, only by contact with opiates, agreeable foods, &c. is too well known to dwell upon them. Hence may we draw a reason for the good effects of an emetic haust. ex vin. ippec. or a purgative bole ex rhab. cum cal. by largely excluding the stimulating fomes, from these parts without which the cortex will often have no effect.

5. If cordials and things over-heating are given to young or robust patients in the cold-fit, the ensuing hot-fit is thereby rendered so much the more violent, and a delirium or a bad continuant are too often the consequences ; but while thirst urges, they may, without danger, be indulged with sage, lavender, or chamomile tea. In such persons, under signs of fullness, you will rather have a call for the lancet, in the spring

spring season; and if you find a fizy rich blood, repeat it discretionally: after which, in the autumn especially, you will generally meet with no small benefit from blisters, when an emetic or two have preceded. Afterwards the following bole and draught may be repeated six or eight times betwixt the fits, with nearly the same success as the bark itself, as a substitute for that celebrated drug, where it is not to be had: viz. ext. r. helleb. nig. g. myrr. camph. alum. rup. $\bar{a}\bar{a}$ \mathfrak{z} j bals. traumat. q. f. ut f. bol. cum haust. seq. sumend. viz. aq. menth. vulg. f. \mathfrak{z} j β . tinct. cinnam. \mathfrak{z} β . (salis absynthii vel potius) salis diuret. half 3. fyr. \grave{e} cort aurant. q. f. ut f. h. horis alternis, tertiis, &c. repetendus. But whether the fever be subdued by this or by the bark, in order to prevent a return, the course had best be repeated once in a week, with an intermediate use of a vin. chalib. amar. for a month following.

6. We need not inform those who are acquainted with practice, that the celebrated peruvian cortex, which was first brought into Spain just a century ago, and for its excellent virtues, both as a febrifuge a corroborant and an alternative, is well worth (the price it bore in Dr. Lister's* days, towards the end of the reign of his sovereign mistress ANN, viz.) one guinea an ounce, must be given to about that quantity, in the interval of time which comes betwixt the fits of an intermittent; as, e. g. a dram, in some draught or bole, every other hour: or if it be all taken at once, as hath

* De Hydrope. *Ægrot.* 7.

often been the case among poor and ignorant folks, it will have no less effect upon the fever, and without inducing any manner of injury whatever. But if it be given in the fit, it has the ill effects above (n^o. 5.) ; or if you give a purge upon it, the virtues are gone at once, and the fever returns, unless you repeat it immediately.

Of Inflammation.

§. 51. We should now proceed, conformable to our plan (§. 41. n^o. 1.) to treat of *symptomatical fevers*, that second some other antecedent disorder ; which consequently ought to be enquired after, considered and treated as the principal, in order to effect a cure. But since the nearest and most general cause of them is some irritation, anguish, pain or inflammation, excited by the distemper ; and as these are all in reality the same thing, only diversified by degree and situation ; therefore it will be first necessary for us to consider *inflammation*, inclusive of the former, and in some measure, answerable to the nature of a local fever.

2. An inflammation, therefore, we define, from its essence rather than effects, to be an increased action of the elastic and muscular forces of any particular artery (§. 3.) urging its contents, with a greater pressure and celerity through some or all of its capillaries ; whence follows more or less of a præternatural turgescence, heat, redness, and often throbbing or pain. This, being extended through the whole, or majority of the habit, completes the essence of fevers (remark to §. 127.) but more con-
fident

fin'd to some one organ, is the character of inflammation : which last, however, is not to be found in any remarkable degree or extent, without an universally quickened circulation, that not unfrequently mounts up to a symptomatical fever. The essence then of inflammation, as well as of fever, consists in a greater arterial pressure, increasing the motion, attrition, and heat of the elastic and cohesive fluids, as well against themselves as against the sides of the small arteries. So muscular motion, long continued in any particular limb, will stimulate the artery into a temporary inflammation ; which having the retarding capillaries freely pervious, and without any febrile matter, soon ceases of itself by rest. So the blood's course, impeded through the genital arteries, by a pressure on their veins, more distends them to a greater force, that produces a temporary inflammation, not morbid.

3. The degrees, symptoms (n^o. 2.), and consequences of an inflammation, will therefore, depend (1. on the more or less nervous fabric and nature of the arterial distributions, through the parts affected (§. 31.). (2.) On the nature of the febrile or inflaming matters and their complications (§. 33. n^o. 3.). (3.) On the number of retarding capillaries rendered impervious, either by those collected matters, by erroneous or violent strayings of the larger globular juices, or by organical compressure from the larger distended trunks, upon their lateral and less resisting capillaries. The number, degrees and complications of all which

will cause the blood to pass into the veins, with a celerity or momentum proportionably increased, through those capillaries that are yet pervious; while those that are less, or not pervious, will act as so many cryptæ or secreting ducts to the sanguine artery, for collecting and forming the most cohesive and sluggish parts into a pleuretic phlogiston, described in our remark to Vol. I. p. 147.—(4.) On the density (§. 8.) and the fullness of the habit (§. 13.) excited by various causes, and enabling the artery (not overstrained) to act with greater elastic and muscular force; and to urge the denser blood itself with a greater triture and momentum. Thus a begun phlegmon in bad habits, breeds pain and phlogiston; and these stimuli increasing, again augment the inflammation, 'till it either disperses the lentor into the veins, melts it with the impervious capillaries into a laudable cream-like pus, or turns it to a corrupt gangrene; or lastly, dries them into a dead scirrhus, that may soon become first a latent or encysted, and then an ulcerated or running cancer, n^o. 9, seq.

4. Inflammations of the external parts appear plainly enough, by the effects (n^o. 2.) inseparable from its essence or character; but when it lurks within the viscera, the eye cannot reach the tumification and redness, nor the touch perceive its heat and throbbing; nor even in the liver, heart, lungs, or encephalon, can the patient inform you of its pain. However, in this obscurity, the hardness of the pulse and the phlogistic sizziness of the blood will always be

be a faithful index of an inward true inflammation upon some of the viscera; whose seat you are to determine by the apparent absence, injury or alteration in the uses or actions proper to the affected organ. Hence we see the proximate cause of inflammation is a local fullness or accumulation of the blood in some particular artery, which, præternaturally distended, acts with a greater spring and muscular systole in each pulsation, causing an increased heat or triture, in proportion to its own density, and that of its included blood. Vid. remark, Vol. I. p. 121.

5. But there is an observable exception to be made from the foregoing rule (n^o. 4.), in what we may call a suffocated or depressed inflammation, extended beyond the tone of the arterial forces in the cortex encephali, in the pulmonary arteries, and in the arterial branches of the porta in the liver; [to which we may add, such as are violent in the neck, phauces larynx, and heart itself, with the diaphragm or pleura, and its incumbent muscles]: for as a moderate degree of inflammation in these parts will exhibit an index of an inward phlegmon (n^o. 4.), by an increased flow of blood and nervous juices, so a much greater degree, by accumulating the matter, and by shutting up the capillaries (n^o. 3. (2.) and (3.)), will so far intercept the course of them both, as to afford a weak, soft, and often a trembling or intermitting pulse. And here, if there be no bilious colliquation (§. 35. n^o. 2.) a plentiful blood-letting will so far relieve the vital springs oppressed, as wonderfully to raise

the pulse, and frequently excite a relieving sweat, a purging, a thick urine or a spitting; by restoring to the emunctories, in like manner, their former free and pervious habit.

6. Therefore, in all true inflammations (§. 51.) of any considerable extent, the greater action of the more distended artery causes a stronger compressure, a swifter current, and a more violent triture of the cohesive and elastic blood-globules; thence a burning heat, a distending pain, and a turgescence of the cellular and less resisting fabric of the least vessels, into which the yellow serum or the red blood are more or less transposed, not by a spontaneous, but a forced straying out of the sanguine arteries; whence a yellow, an orange, or a red colour of the parts. Thus the inflammation will increase itself to a degree, that may end it one way or the other (n^o. 3. ult.); and at the same time, according to the extent or degree of it, with the structure, sensibility, and consent of the organ, there will be more or less of a fever; a hard quick pulse; a short and laborious breathing; and a deep coloured or red urine, with or without a sediment; of which the last proportionably denotes concoction and amendment; but being thin and watry, declaims the worst events.

7. A phlegmon, from causes not local, is most apt to invade (1.) those parts that have the strongest arterial powers; therefore those of the heart, arterial trunks, lungs, and respirative muscles; as they densify more, and earlier by incessant action: (2.) from the less extent

and subdivision of a similiary artery from the heart ; for so the left intercostals, being shorter than the right, more generally cause the pain to be on that side, more violent in short thick persons, and in one a thick skin, dark, opaque, and coarse habit of body in the vascules subdivide more directly and less frequently into retarding capillaries : (3.) from the considerable resistance that contiguous bones make to the dilating arteries, by which reaction the distending force is doubled on the opposite side of the artery less resisted : so with the ribs, in regard to the intercostals; the dura mater and pericranium, with regard to the skull, and spina dorsi; the arteries of the periostia; external and internal, perichondria and those spread on the joints, tendons, and ligaments. Hence the reason, why pain and other effects of general phlogistic causes, which breed a lentor or excite a plethora (§. 16.), are felt more and sooner in those parts.

8. We must well distinguish betwixt the *true pblegmon*, that has a fizy dense blood and artery, from the *cold œdematous* sort, that arises with pains from albuminous or aguish viscid in weak, lax, and nervous or hysterical habits, with a poor watry blood, but little cohering ; because they are diametrically opposite, both as to their effects and cure : for though the lancet, diluents, refrigerants, &c. that effectually cure the first, may, for a little time, give a direct truce to the pain, which is here a natural remedy ; yet, as they increase the immediate and productive causes, the distemper will be more

deeply intrenched, and the symptoms be more difficultly removable, by the bark, bitters, g. guaiac. (blisters in both) nervous and corroborant medicines, &c. But an *erysipelatous* inflammation, in which neither of those lentors prevails, only a scorbutick, or a bilious dissolving acrimony in the blood and lymph, in a lax, delicate, and irritable habit, requires a sort of intermediate cure, as it comes in betwixt the former; viz. evacuations, but such as are slight cuppings, leaches, laxatives, clysters, oily and ascescent emulsions, without blisters, unless for revulsion from the eyes, cheeks, throat, &c. If the acrimony be bilious, or alkaline, use bark with mineral acids; but if of a cold, sour, chlorotic, or leucophlegmatic kind, give the same with vol. alcalies. myrrh. camph. rhab. &c. Observe then the affinity, both in the nature and cure of inflammations, greatly conformable to those of fevers (§. 33. n^o. 3.).

9. Nor is their difference more with respect to the events or terminations; for if, in a true phlegmon, the collected lentor by degrees melts in the oppilated capillaries of the artery, so that without breaking their fabric, it can pass on into the veins, the part is left safe and sound, while the matter is afterwards thrown out by the kidneys; and this we call the resolution, or (1.) *dispersion* of a phlegmon. But if the said lentor dwells long enough in the phlegmon, not only to melt its own cohesion, but also that of the least vessels oppilated, and the globular texture of the blood, it breaks the continuity betwixt the artery and vein of the part,
and

and pouring itself out into the cellular fabric, there digests into a thick cream-like mass, without smell or taste, called the laudable pus or matter of an abscess; which is therefore said to terminate the phlegmon (2.) by *suppuration*. That the lentor will come to this pass, one may conjecture, from the great degree of the fever, and incorrigible inflammation, from the exceeding vascular and cellular fabric of the part itself, lying very near or open to the force of the heart, or in a young, robust, and full habit, sustained by too high aliments or medicines, with the season, clime, &c. But that matter is now forming into a collective body or abscess, we conclude from the shuddering qualm, that is perceived and followed with a subsiding of the pulse, fever, pain, &c. the accessible part also is now soft, easy to the touch, and by degrees forms a point or dependancy. But if by defect of these causes that advance suppuration, the lentor lies in more pellucid and unactive arteries, (much complicated and confirmed by dense membranes and cellular strata, in the fabric of the glands, the womb, bladder, stomach or viscera, and cellular substance of some parts) unable to advance, the watery and more fluid parts are drained off, while the rest, more thickened and hardened, close up the least vessels and nerves, within reach into a hard unorganized mass, now to be esteemed a dead or foreign body, called (3.) a *scirrhus*; which yet often leaves so many living or sensible nerves and blood-vessels, intermixed in the mass, as will cause an irremoveable tormenting pain, which

which immediately denominates the scirrhus a latent or enclosed *cancer*; in which the secondary and incorrigible inflammation now begun, soon causes a gangrenous or corrosive dissolution of whatever lies near, so as to turn the latent into an ulcerated or running cancer: familiar to which, in the more tender and vascular parts, liable to suppuration (2. *supra*); and from like causes ensues (4.) a cadaverous *gangrene*, that by destroying the vitality and fabric of the vessels, soon ends in a compleat *mortification*.

10. As the crude phlogiston often removes a phlegmon from one part to another, so the digested lentor of a fever or phlegmon, that differs from laudable pus, hardly more than chyle from milk, being retained in the habit for want of a free deposition, by a spitting, by the urine, or by sollicitations, with laxatives from the intestines, commonly gathers into an abscess within some of the viscera, or some loose part of the cellular substance; whence vomica's, empyema's, &c. of fatal issue. So the latent matter of a neglected abscess will often remove, from a less to a more important part; from the surface or extremities, to the lungs, liver, or mesentery, &c. where it must be soon destructive, if the translation be not timely checked by opening the first abscess, or by making new artificial ulcers, scarifications, issues, setons, caustics, &c. And in like manner, an ulcerated gangrene or cancer, if not timely extirpated, is by the corroding ichor transferred to other, neighbouring or even remote parts of a similar fabric.

§. 52. The cure of true inflammations, no less than of pains, arising from a phlogistic size, in parts of consequence, will depend upon a timely and free use of the lancet, conformed to the patient's strength, the blood's tenacity, and urgency of the symptoms; to which add the mildest laxatives, that empty the bowels without heating [sal. diuret. | crem. tart. | sal. glaub. | manna. | syr. rosar. sol | elect. lenit. | infus. fen. lim. &c.]; plenty of diluent liquors, repeated clysters, oily and mucilagnious emulsions, charged with honey and nitre; sometimes sp. nitri. d. acces. camph. and papaverines that relax convulsive spasms in the viscera, and excite or promote a relieving discharge, by a spitting, a gentle diaphoresis, or a diuresis; so as to resolve and disperse the matter from its seat, and expel it from the habit. An inflammation upon any of the emunctories will (if in a small degree) excite a wasting discharge, or increased secretion; but in a greater degree, it will even suppress natural discharges, which the lancet directly restores. Thus the brain slightly irritated or inflamed, makes an increased flow of spirits to the nerves; whence sharpness of wit, wakefulness, &c. but the arteries further distended, intercept the flux, and cause a delirium, coma, convulsions, &c. So a slight inflammation in the alimentary passages, makes a simple purging; but in greater degrees it causes a dysentery, or a constipation, that threatens a speedy gangrene. In a nervous organ for sense, it will thus either deceive, change, or abolish the sense; as in a nerve for voluntary or spontaneous

taneous motion, it will cause a cramp, tremor, palsy, &c. and so of the nerves of the viscera, in secretions or other actions.

2. Thus in plegmon, the different degrees of its intension, the several stages of its extension, through sanguine, serous, and lymphatic arteries, even to the smallest recesses of the cellular fabric, and the diversity of peculiar organization, or action in the several parts; will furnish out a subordinate distinction, as much more puzzling, as exceeding those before given (§. 41.) of fevers, which, however, may serve to reflect some light upon the variety of the nature and treatments of different inflammations.

—Conformable to the elastic and the muscular powers of the arteries, which vary in every organ, we frequently observe that a total or partial occlusion of the anastomosing capillaries by lentors, &c. cause a proportionable retention in an extension of that artery, which by its increased spring will, in a conformable degree, urge its blood swifter through the other capillaries that are pervious: but besides this equable acceleration from the increased spring of the more extended arteries, which continues, and urges on the blood and juices many days after a person is dead, the said fulness will act upon their muscular or nervous powers as a stimulus; more especially if it amounts to pain; whence again the inflammation will differ in degree, extension, and effects, as the organ is more or less nervous, and makes various consents (§. 555.): but when this extension of the artery exceeds a certain degree, beyond its native powers, the

the blood then more stagnates through its system, and puts on a state like the blood in the spleen, whereupon the phlogistic lentor dissolves, which removes the distemper by dispersion (§. 51. n^o. 9. (1.)). The same is also true of fevers, which till their height, are an excited and temporary plethora of the arterial trunks, induced by all causes that either too much increase the action of the heart, or add to the capillary resistances; and accordingly original fevers (§. 41.) that are flight, ephemera's, or from mere externals, may like inflammations be dispersed; but those which have a lentor, with or without acrimony or contagion, require to be continued a certain time, and regulated to a certain height, which makes the digestion or maturation in fevers, answering to the suppuration of phlegmons; for as we have observed, the digested matter of a fever differs only in degree, by being of a finer consistence within the entire vessels; as milk differs from chyle, in being made from the more attenuated and fine parts of the latter, in the breasts.

3. Since the laudable digestion of the lentor, into an insipid and inodorous cream-like matter both in fevers and phlegmons, depends upon keeping the elastic and mucular powers of the artery, elevated in moderate degrees beyond the state of health; if they are permitted to sink lower, the phlegmon turns to a scirrhus, or the fever lingers 'till the patient is exhausted by it: but if urged violently and precipitately above the mark (either for want of abating or removing the urging causes, or from stimulant ingesta,

ingesta, and applicata, in diet and medicines), the scirrhus turns to a cancer, the phlegmon to a gangrene, and the fever ends by a begun mortification, either upon the brain, lungs, or stomach, and bowels, &c. Therefore the skill and successful practise, both of physician and surgeon, will depend mainly upon this article (§. 33. n°. 3.). Hence you may be able to answer, whether, or how far it may be necessary to abate a fever or a phlegmon; and when, or how far, they may properly be increased. As for topical phlegmons, and the consequences which they leave to the proper treatment of a surgeon, they are not within our present enquiry, but may be seen at large in the four first octavo volumes of Van Swieten upon Boerhaave, which contain what ought to be more especially known, by every good surgeon in his profession. As for dropfies after fevers, no less than anasarcaous swellings in the cellular substance, after local phlegmons, they come from an over-strained, and now relaxed artery, making a loose, serous, or uncompact blood; and must therefore be removed, not by purges and evacuants, but nervous roborants, exercise (§. 6.), and the bark; although the vulgar unjustly impute the disorder itself to this last, rather than to the fever, if they know it has been used in the cure.

§. 53. From what has been already advanced upon fevers and inflammations, we deduct the following rational and practical conclusions.

(1.) That as in all acute fevers and inflammations, there is a pleuritic size bred in the blood, oftener as an effect from them; but frequently

as

as a generative cause of them, from over dense solids and fluids, laborious life, hot climate, &c. Therefore, if this does not appear in the blood, taken from a freely opened vein, while the pressing symptoms show, that the height is still approaching; we are then assured, it is either *retained* within the body, collected out of the high road of circulation, within the capillary system of the encephalon, lungs, or porta of the abdominal viscera; or else that it has suffered a *colliquation*; either (1.) *morbid*, from transfused bile, scorbutic, gangrenous, poisonous, contagious, or epidemical acrimony, which also melt the organic texture of the sound fluids and least vessels; or (2.) salutiferous and *critical*, when the height of the distemper appears turned, with any relieving excretion of the digested matter.

2. That though the hydraulic experiments, which have been made in behalf of the important subject of arterial obstructions, prove, that considered as a dead and unelastic vessel, the obstructed branch may be esteemed intercepted or cut off, with respect to any action upon the fluid; and that the acceleration thereby produced, will be inconsiderable, because equally distributed through all the branches of the system: yet we have shown, that within certain latitudes, it will cause an increased spring, like that of compressed air in the fire-engine, first and most in the branch obstructed; and that it will also act upon the affected artery, considered as an involuntary muscle, with the powers of a stimulus, irritation, or pain; from
both

both which all the consequences of obstruction and inflammation are mechanically deducible, as they are elegantly proved by our great Boerhaave, how much soever some gentlemen that are better versed in the hydraulics of art than nature, may insist to the contrary.

3. That these powers of the arteries give the forces to those dead tools we call medicines; and as these powers are various in different organs, ages of life, constitutions, &c. therefore the effects they work by those tools, will be accordingly different: e. g. the *essentia stibii**, will in a clyster make a revulsive purgation, in the stomach a vomit, in a lessened dose, it will be diaphoretic and sudorific; with papaverines, and terebinthinate balsams, diuretic; or with camphor, and the foetid, or lactescent gums, it will be an useful expectorant; as with myrrh and extracts from elleb. nig. cort. p. &c. it will be a most powerful alterant and deobstruent.

R E M A R K.

* This is on many accounts preferable to any of the powder forms (of which one prepared by calcining antimony, with, harts-horn chips, is now much in vogue for fevers); and made by infusing an ounce of the vitrum antimonii pulverized, with as much of the yellow of lemon-peels, in a pint of white-wine: which decanted, and given to an ounce, vomits in a draught; or in double that quantity, it purges by clyster; but under two drams it purges by the stomach, as under one dram it will be either diuretic, sudorific, or perspirative; or reduced to a scruple, or about twenty drops, it proves insensibly alterant or deobstruent: but generally 'tis best to
 bridle

bridle and determine its operation as above, since it is otherwise, in itself, often a weather-cock of a medicine, moving all ways, or no way at all, according to the particular affinities of the minima naturalia, and morbosa, that it joins in the course of the alimentary, sanguineous, and secretory passages.

4. We have seen that the heating regimen and medicines, before the height of inflammatory fevers, are mischievous, by augmenting the quantity, and condensing the quality of the phlogistic size; and by impacting it into the weaker capillary systems of the encephalon, lungs, liver, or mesentery, so as to be afterwards inflexible to all the powers of the lancet, blisters, diluents, attenuants, or revulsives, &c. whereas in the aguish or albuminous lentor, they have a contrary and salutary effect, given at a time when the said matter does not form a gathering in the whole arterial system, or that of some one organ, so as to cause a morbid paroxysm; for if these, or even the bark and other restrictive corroborants, be given in the fits, either of local or general intermittents, they condense the fluxile matter into, or towards a phlogiston, and fix it like a wedge farther into the narrower passages. So these and refrigerants externally applied, to inflamed parts, will often fix a lentor, that might be either dispersed or digested, into a schirrhous, that may be soon cancerous; or even change it to a gangrene, that may be soon a compleat mortification.

5. For the same reasons all evacuations, except the lancet, and those that gently turn out the mere contents of the stomach, and intestines,

tines, are also pernicious; by compacting the lentor, and universally drying up both the fluids and solids—We see hence a vesicating or ulcerating erysipelas may supervene a phlegmon; when in about the space of a week, the phlogiston in a debilitated part, and cacochemical habit, has relented and corrupted, for want of a laudable digestion into an ulcerating or corroding liquid, that penetrates into the serous and lymphatic vessels.

6. That a soft pulse, though there be no bilious or contagious colliquation, nor any considerable phlogiston apparent on the blood, is however not always to be trusted as a sign of no inward inflammation, or a constant impropriety for blood-letting: because we have shown such a pulse may attend an over extension of the arteries beyond their powers, which then increase by the lancet; and often we have such a soft pulse when an inflammation of the encephalon intercepts the nervous flux to the heart, arterial, and respirative forces; or when the course of the blood itself is intercepted from the right side of the heart and the aorta, in a violent peripneumony; or when a great part of the mass lies collected and blocked up in the portal system, in a manner useless, both to the heart and encephalon; and when but little phlogiston appears on the blood, in respect to what it before exhibited, we have often worse consequences to apprehend from its hesitation or lodgment within the capillary systems of the said important organs.

7. That

7. That an inflammation increases itself not only by augmenting the obstruction (n^o. 20. supra.), and the quantity of phlogiston, but also by abrading the defending mucus, which, like that of the bladder, distils by minute ducts, all over the epithelium arteriosum; but most evidently in the larger trunks, to defend them against excessive irritation, from increased acrimony, or impulsion of the blood: for the arteries are as impatient of acrimony as the bladder, without this mucus; and as the bladder is impatient, even to a spoonful of sound urine, when its mucous secretion is either suppressed, or rendered too thin to adhere, by a stranguary or inflammation of its coats; so the arteries cannot bear the fretting even of sound blood, if this mucus be dissolved or washed out, either by mineral, or even common spring waters (unjoined with some vegetable or animal mucilage, and this is one reason why the bladder and the arteries throw out mere simple water, as fast or faster than it can be thrown into them. And here I must take upon me to vindicate a practice of the late penetrating and successful Dr. Radcliff; which (because many, and perhaps sometimes himself, may have extended it to an excess, and because the reason a priori did not so readily appear to some of our sharp-sighted moderns, has been of late too much neglected; I mean the exhibition of well prepared testacea, particularly the ostreodermata, with pulv. trag. and other mucilaginous compounds, in the increase of ardent fevers, where they are of use, as well as nitre, by a peculiar faculty of renew-

ing or generating this necessary mucus: for the oyster shell, we know, forms a mucilage, by dissolving with a weaker acid than vinegar, like that which commonly lies upon the stomach and guts; and that some of the finer parts may enter the blood, not only in that shape, but also in its natural condition, is highly probable, both from experiments of indigoe passing the lacteals, and from those of madder penetrating and colouring the bones.

8. As the laudably digested matter of a phlogistic fever, is like that of an abscess, without acrimony, and retentive of its innocency for several days within the habit; therefore we are not to hurry on or excite a flood of it upon the emunctory, to which nature has given it a tendency; only to forward her by the most gentle provocatives, when she appears over sluggish, and even to moderate or check her, when too excessive or precipitate in her discharges: for by this precaution, the whole vascular system is better sustained, and gradually depleted, without small loss to the strength both of the whole, and the part on which it is settled; in the same manner as a magazine of laudable pus, to sustain the parts, let down their tone by degrees, and exclude a wasting drain, is best exhausted in small parcels, or at several times.

9. On the contrary, where the strength of nature appears of herself unable to bring the matter regularly to a critical discharge, and its longer retention in the habit threatens to change it into a putrid, hectic, or consumptive acrimony; in order to save the patient, we must
here

here solicit an artificial crisis : for thus in many slow or lingering, somewhat nervous and malignant fevers, small repeated boles [ex rhab. & cal. | vel. haust ex. infus. sen. cum. man. sal. g. &c.] will bring out by day a good deal of the matter lurking in the mesentery and portal system ; as draughts with papaverines, sal. diuret. and terebinthinate balsams will by the kidneys at night ; and if both of these are insufficient, artificial drains are to be excited by incisions in the neck, under the ears, in the back, thighs, and arms, &c. to be treated as setons or issues? keeping up your patient all the time by plenty of liquid and light nourishments, in proportion to all his discharges. Thus, several we have seen apparently withdrawn from betwixt the jaws of death.

10. From hence we need not be surpris'd, if in the end of many fevers the said matter gathers to an abscess, in divers parts, without exciting any previous inflammation ; in which case we need wait for no maturation, only to relax and solicit by watery foment, or an emollient plaster.

11. We see there is no less difference in the effects or symptoms, than in the causes and intrinsic natures of the two febrile lentors (§. 33. n°. 3.) ; for as the size of inflammatory continuants causes a greater strength or density, cohesion and triture, betwixt the parts of the fluids themselves, circulating, and betwixt the vessels through which they are protruded, it gives to the patient a sense of burning heat, more especially in those arteries where its triture and mo-

mentum are greatest, and its quantity abundant: whereas the albuminous viscid of remittents and intermittents, interposing as a crude alimentary mucilage, not yet wrought into the nature of animal substance, betwixt the tensile arteries, vibrating on their current blood, and betwixt the elastic vibrating parts of the blood itself, produces an actual diminution of the animal heat, by lessening its cause as above, during the well interval, and an apparent or sensitive one in the cold chill, which to the thermometer exhibits preternatural heat; because, though there is actual cold generated to give the sensation, in some of the capillaries that are gradually obstructing at first, yet their re-action being turned upon the rest that remain pervious, causes in them a greater heat or triture, more especially in the circumference of the body, to which thermometers are applicable, while the viscera are in reality under a preternatural chill, until the powers of the arteries arise over, and remove the impediment into the more patulent veins, which increases the heat universally and really, both as to sensation and fact, in what is therefore called the hot fit, which terminates or relieves the distemper for that time.

12. We observe a two-fold heat in the animal body, which being generated by the elasticity and vibrations, both of the vessels and of their inclosed cohesive fluids, is not imitable by any hydraulic engines, formable by art: which has no power to make tubes that will act on their fluids, both with the elasticity of a bow, and with the vital force of a muscle; nor to
make

make current fluids that approach the nature of solids, both elastic and organcical, as well albuminous, like the blood, serum, lymph, and finer parts of the last, called juice of the encephalon and nerves. The heat, which is generated by the aggregated sum or degrees of these powers, in animals, is absolutely various, not only in different animals and different persons, but in different parts of the same person; in different arteries, and in different parts of the same artery, in which the heat called *original* arises, and is thence by contact and communication of parts, transferred from one to another throughout the whole, nearly or sensibly to an equality; since the best mercurial thermometers of Farinet's scale, shew, that in warm or temperate weather, there is seldom more than three or four degrees more of heat within the body, than upon its circumference; but in winter the circumference loses six, eight, or ten degrees of heat into the air, below the temperature of the viscera. This difference of temperature in the skin, betwixt winter and summer, makes a considerable change in the halations we call perspirable and inspirable. In summer, the perspirable exhalation of the lungs, which always equals or exceeds that of the skin, in temperate climates, is not only less to the appearance, but also in fact; proportionable to which, the inhaling or absorbing power is here increased; and this is one reason why a morbid infection or epidemical contagion, is sooner taken this way, in the summer than the winter. The reverse of this is true of the skin, whose

diminished winter exhalation is thrown upon the lungs or alimentary passages, while the excrementitious parts of it are exterminated by the kidneys, or, being retained, give birth to those fevers we call colds, that often degenerate into others, that are either aguish, inflammatory or malignant (§. 33. n^o. 3.).

13. The Bellinian doctrine of heat and inflammation, arising from the capillaries, less pervious or obstructed, judiciously approved and circumstantially taught by our great Boerhaave, is not less true, even at present, for having been over-hastily deserted by the ingenious Dr. Grother, Wintringham, and several other worthy professors, bred under his dictates. For it should be remembered, that the excellency of the Boerhaavian system, both as to theory and practice, by what I can recollect of it, from a laborious but instructive distillation it has suffered thro' my quill into the English tongue, lies greatly in assembling all the causes, natural or unnatural, that concur to any effect, in determining the degrees that are remarkable in each, and ascribing to them all the share that is their due, in producing one or many effects. Here then the philosophic rule, that the same cause will have the same effect, is not true; unless you limit both the concomitancy and degrees of the cause, with the conditions of the subject, in which any change is produced. Thus, as a small heat will dissolve an albuminous mass, such as the blood, lymph, eggs, fish, &c. but a larger heat coagulates into an irresolvable solid; so, in the same manner, ob-
struction

struction, in different degrees, will have contrary effects. As the fluids driven by the same force of the heart and artery, have a less momentum and celerity as they pass over a greater space; any thing that will shorten their course, will, in proportion, augment their celerity or momentum, while there are nearer passages left open, and the urging powers continue the same. Thus, for example, the serous arteries and exhaling ducts of the skin, by their influent juices, both receive and abate a part of the heart's force, transferred to them by the blood and arterial trunks; but if, by external, sudden and long continued cold, some of the said vessels are rigidly contracted, or oppilated by their sluggish juices condensed, the juices, losing so much of their course, (while the urging powers remain the same, or are rather increased) return so much more abundantly, with an increased celerity through the veins to the heart, which is proportionably more stimulated by it into action. This increased action being equally transferred through the whole body, will have its effects the less considerable; yet it will be something, amounting more or less to a slight fever; because thus the heart and arteries are more distended and irritated within incrementive bounds, both of their tonical and muscular powers, now more strongly irritated by a sharpening blood and abrasion of their defending mucus; and this in so much a more eminent degree, in the parts first affected, as to cause there different symptoms, which we see occur in the inflammations of different organs, according

according to number and quantity of the concomitant causes and vascular fabricature of the parts. But the case is widely otherwise, when a much greater degree of obstruction and arterial distention shall have almost suffocated the elastic and muscular powers of the heart and arteries; shall have almost occluded the venal returns into the heart or arterial trunks, and intercepted the nervous influx from the encephalon to them both; while that principal, and all the other secretions are perverted, by the now vitiating blood moving with undue forces, and into improper vessels. Thus inflammation will not only arise from a circumstantial obstruction, but, in different degrees, will both increase and suppress a secretion; and, with other circumstances, will either disperse, suppurate, indurate or mortify in one and the same part.

Conclusions.

§. 54. Thus we see (n^o. 2 and 13. supra) the Bellinian position, *that obstruction will increase the celerity of the blood within the arteries to inflammation*, is both true and false, under different circumstances (§. 51. n^o. 2 and 3.). But as we are now arrived near the just limits of this compendium, it will be convenient for us to cut or wind-up the thread of our nosology, by reviewing in miniature the principal points advanced through the lectures; such, at least, as are to be called upon and examined regularly in the course of a distemper, towards a ready, safe and sure practice. For as the human body is to be readily traversed, by our enquiry, like

a great city, in divers quarters and streets of which we are to pay our visits, when they are due, either complimentary or salutary; so a practitioner, unacquainted with the seats of the public offices, and high or directive streets of action, that are to lead him through the distempered body of his patient, is like a traveling gentleman, who, arriving at a metropolis, has therein many old acquaintance, which he must pass unconverted, because he knows not how to find them, who might have pointed out the best, nearest and safest roads to end his journey, with innumerable and collateral advantages. Thus perplexed, for want of knowing our inward frame as the subject, those who are otherwise tolerably well acquainted with the objects of healing, viz. distempers and medicines, are often ready to steer their course rather by common index and set prescription, than by the true compass of mechanical reason and relative observation, which ought as much to be pleaded for every procedure in physic or surgery as in law, by those who think their lives even less than equivalent to their estates. Yet we see amiable self-conceit and idle prejudice not only spur many to quack themselves, but also their friends, out of the world, by rendering their case, either thro' delay or ill management, irremediable to all the powers of art or skill of physicians.—The ingenious sculptor or painter indeed stands, in general, upon the same advantageous footing with a good surgeon, as the use both of the eye and touch are, to each of them, guides equally sure as sensible:

sensible : but the physician is obliged to wade much farther than the out-lines of sense : his reasonings must lead him successively through the whole labyrinth of our interior fabric, by tramping backward and forward in silence the philosophic chain, that joins together past causes and present effects, present appearances and future events. He must call out and examine every present witness of the distemper, that declares for or against each indication to be pursued ; as directive of the several remedies, aliments, and internal medicines to be used suitably as to form, time, dose, combination, and inferior circumstances.—Physic being, like sculpture or painting, an art that is practically imitative of, and coadjutive to nature ; is not therefore less a discretional science, to be conducted by rules that are not strictly mathematical, but subject to relaxations equitable or discriminative, according to all material circumstances, considered and allowed for.—A person, who, with an air of keen apprehension and ready dexterity, shall instantaneously prescribe usual medicines, in the general doses, and common mixtures or proportions, without regarding the material considerations hereafter specified, is just like a limner, who applies the common lines, proportions, and features of a human face in general, to represent each individual countenance, of which he is to make a copy. However, generals must precede as the basis, and particulars must be superadded for the finishing, by a growing reason and experience in all faculties ; of which that of physic, upon
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the ample, solid, and mechanical plan on which it now stands, is, from all circumstances considered, absolutely the most difficult.—We have already, in §. II. of our historical introduction to the preceding volume, given the most general and contracted idea of the human frame that we are able. We shall now only subjoin a brief physiological view of man, as he is the object of life and health, and liable to become the subject of diseases and death, with references to the several preceding lectures, in which you may see the particulars more fully explained.

Anacephaleosis.

§. 55. The preceding lectures then have taught us, that man is an *animated automaton*, or most complex natural engine of the hydrau-
lic kind, including all the powers of nature, mineral, vegetable, animal and intellectual; employed in the faculties of nutrition, sensation, muscular motion, and procreation: which four last include all the other powers or possibilities of action throughout the body; that is to say, the *faculties* of all the organical parts and viscera are maintained in power or possibility of acting, either successively or simultaneously, by two *forces* or springs of perpetual motion, which, like those of a watch, mutually influence and excite each other: viz. (1.) the *encephalon*, and the nervous system produced from it; or (2.) the *heart*, and the sanguiferous system produced from it. Both these mutually excite each other, like the fusee, or
barrel

barrel spring ; and the regulator, or pendulum spring, in a watch ; and together they actuate all the rest of the movements, that are made up of solid threads and tubes, more or less elastic and irritable (lect. I. to lect. IV.). All these movements, called by the name of organs and viscera, are carried on, or maintained in their actions, by a circular endless chain, of elastic or globular and albuminous juices, gradually drawn out to a finer texture and consistence, conformable to the exility of the vessels themselves, which they pervade (lect. IV. to lect. VIII.) ; which fluid chain requires perpetual alimentary recruits, to wind-up not only the two main springs, but the whole tubular system. These alimentary recruits are first lacteal, then serous, then sanguine, then lymphatic of various kinds, and lastly nervous ; but all the way globular, albuminous, and sweetish or insipid, in their most healthy state ; and made all from the same nutritive jelly, either vegetable or animal, farther digested or extenuated.

2. The mineral powers of nature are employed in the bones, teeth, and ultimate appositions of matter to the solids ; as the vegetable powers are employed, both in the hairs, nails, cuticle, consistent and motive parts (§. 3.) ; in the productions and reproductions of the vessels, and the cellular cobweb-like fabric of which they are formed (lect. VIII. and IX.) ; and the animal powers are employed in causing motions in the muscular fibres, and giving sensations to the intellectual mind, by impulsions
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of a nervous fluid, in a manner which the creature has thought fit to conceal from us : but then these powers are so linked one to another in us, that the former always presupposes the latter to be operating, to put or keep them in action. These powers are assembled together into many complex viscera, and those viscera are again assembled into three organical systems ; lodged each of them in a higher story or venter, according to their superlative dignity, and as they are sustained one by the other ; and have been commonly called, either

I. NATURAL organs ; including those that make and convey either * (1.) the chyle, (2.) the urine, or (3.) the foetus ; and take up their residence in the three cells or chambers of the *abdomen*, called supra-colic, infra-colic, and pelvis. Among the first of these, some make the *chyme* or alimentary pulp, which beginning from the mouth and its furniture, are compleat in the upper or supra-cholic chamber of the abdomen (lect. XXI. to XXIX.) ; including the stomach, liver, spleen, pancreas, and their appendages : others mix, emulge, protrude, separate, and convey the *chyle* or lacteal juice from thence, seated in the middle or infra-colic chamber of the abdomen (lect. XXIX. and XXX.) ; and others collect and throw out the morbid and useless dregs or faeces, that remain from the emulsion (lect. XXXI.), and so make the natural, (and with the gula, sometime the morbid) *emunctory of the first passages*, which are said to make the first concoction or digestion. The organs that make, collect, and

* i. e. Chylopoietic ; 2. Ourupoietic ; 3. Paidopoietic.

convey

convey the urine, are also the proper emunctory of the second passages or concoction for throwing out from the blood, all gross and morbid fæces and superfluities of the circulating humours (lect. XXXII.); while those, which make and convey our species into the world, we see are, either masculine or feminine, differ in each sex (lect. XXXIII. to the end): but those, and the uriniferous parts, we observe, are either upon or within the lowest chamber of the abdomen, which we call the pelvis. As these parts, with their contents and offices, are naturally the least agreeable to the superior organs of sense; and as their appetites, when vitiated, are the most liable to deprave both the animal and the intellect; they are, therefore, wisely placed the farthest from the head and observation: but being those without which all nature must fail, they are fixed by our creator, as the fundamental or ground-story to sustain the rest. Above these reside.

4. II. The VITAL organs, including those which make, move, and distribute the blood, duly guarded each way by a light movable cage or fence, called the *thorax* or middle-venter (lect. V. to XI.); and are so named, because, *ex vi & alimento*, they immediately sustain and give action not only to themselves, but to their subjected servants, and to their superior and capital masters. Thus the heart, lungs, and blood-vessels, as the seats of sanguification, have various *emunctories* or out-lets; some merely excrementitious as the kidneys, skin, and lungs; and others salutary, for clearing
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ing the blood, but mostly to return thither again, after exerting particular uses; such as the saliva, mucus, bile, juices of the stomach and pancreas; to which add all of the lymphatic glandules, vessels, and the cellular train, whether with or without fat; so that we may make a peculiar emunctory to these last, either (1.) *useful*, of serum, mucus, jelly, fat, oil or wax, for the cellular web and skins, external or internal; (2.) *recrementitious* or perspiratory; or (3.) *morbid* as transudations, either through the external cuticle, or the internal epithelia (lect. XIV.) This system momentarily sustains and administers matter for the imperial courts of sense and intellect, that superintend the whole, by the name of

5. III. The ANIMAL organs, of the encephalon and its nervous productions; which, being of the last importance to the whole being, and of the most delicate tender fabric, (as well for reporting the various conditions of our little own, as of the greater external world, to the immaterial soul, as for returning again and executing her commands accordingly upon the body) are, therefore, lodged in a well defended castle of observation, every way easily moveable to inspect over her dominions, which are sustained, moved and governed by above 500 capital bones and muscles (lect. XIII.), [which being more the province of the surgeon than physician, are, therefore, the less regarded in these lectures] to execute her sensations, appetites, and various motions, whether voluntary, spontaneous or mixed (lect. XI. to XXII.) We have here, for an emunctory, the least exhaling

or evaporating vessels, which open throughout the whole external and internal surfaces of the body and its several cavities; so as to be partly dissipated, and in part refunded to the chyle and blood. Such a variety of organs are there in man, all labouring, at their respective works, alternately or simultaneously with so much ease and silence, that the bearer hardly knows that he has them; until pleasure or pain gives him a sensible admonition of his earthen companions.

6. What we have before advanced concerning the human organs and their actions, enable us to make the following deductions: (1.) that LIFE is a perpetual circumrotation, segregation, and remixture of the various links or particles that compose a warm fluid, which we call blood, carried on betwixt two springs: viz. the *heart* or vital main spring (n^o. 4. supra) and the *encephalon* or animal spring, with the productions of vessels and nerves from them both (n^o. 5, supra), wound up or replenished daily by the natural or *cylificative* springs (n^o. 3.). (2.) That HEALTH is the aggregate sum of all those threefold powers and actions exercised alternately or simultaneously, with a due degree of harmony or consent one to another, within a certain latitude. (3.) That DISEASE is any discord, excess or defect in the conspiring actions of the solids and fluids, above the said latitude or balance of health, so as to cause any remarkable destruction, pain, or uneasiness throughout the whole, or some one part of the animal machine. And consequently (4.)
DEATH

DEATH is a total abolition or cessation, both of all those actions, and of the faculties or powers from whence they arise; i. e. a stop or rest to all the motions, and the powers generating motions, in the animal engine. (5.)

That **ALIMENTS** are all substances, replete with an oily, insipid or sweetish mucilage, easily convertible, by the actions of the body, into the alcalescent glue, which makes all our fluids and solids, whose daily waste requires to be repaired by allition. (6.)

That a **MEDICINE**, or a *morbific matter* is any ingested substance, whose particles are not thus mutable, by the actions of the body, into the animal nature of its own fluids and solids; to both which, being repugnant or offensive, the enemy is driven by their conjunct actions, outward from the heart, under the conduct of the nervous and arterial powers, with the excreted juices of some emunctory, towards which the matter or medicine is said to tend, operate, and receive a title. (7.)

That a **POISON** is any medicine, morbid matter, or other substance, which, being both immutable by the powers of the body into its own animal nature, and also destructive or invincible to its expulsive forces, remains within the body, whose organism it sooner or later destroys or kills. But custom has applied the name chiefly to the stronger kinds only of these, which kill either in a very small quantity, or in a very short time.—Four of the preceding considerations, disease, death, medicines, and poisons call us from the physiological or natural state of man, to that which

is pœnal to him for disobedience to his Creator, of which these articles are the proper objects, under the title of NOSOLOGY; into which we have here made an entry, by the most frequent and universal distempers; upon the rest of which, we may possibly give another volume, when time and conveniency may be more suitable.

F I N I S



